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ABSTRACT

A measurement device, Assessment of Sensorimotor Integration in Preschool Children, was developed to assess postural control, reflex integration and bilateral motor integration in developmentally delayed children (3 to 5 years old). The test was administered to 113 normal children and results were compared with data collected on 23 developmentally delayed children. Among findings were the following: in the area of reflex integration, the tonic neck reflexes in the quadraped position were the best indicators of integrated function; in the area of bilateral motor integration, symmetrical grasp patterns measured in the rolling pin activity and the ablity to cross the body midline or transfer to a preferred hand were identified as the most basic skills; and cooperating therapists reported they found the test to be useful for 3 to 5 year olds who had gross and fine motor delays, learning disabilities, hypotonic cerebral palsy, and mild to moderate mental retardation. Appendixes, which make up the bulk of the document, include a manual entitled "Assessment of Sensorimotor Integration in Preschool Children" by G. DeGangi, the parent's checklist, informed consent form, sample activities for parents, and a copy of the validity questionnaire. (SBH)

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The Assessment of Postural Control, Reflex Integration, and Bilateral Motor Coordination of Young Handicapped Children

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August, 1979

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The Assessment of Postural Control, Reflex Integration, and Bilateral Motor Coordination of Young Handicapped Children

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Introduction

Some children's developmental problems can be observed in relatively major deficits in gross and fine motor skills that occur in the first few months and years of life. However, less pronounced sensorimotor dysfunctions often go unrecognized until the school years, when moderate to severe learning disabilities appear, because our measurement devices are unable to detect the more subtle indicators of sensorimotor integration. In the absence of standardized testing procedures based on normal patterns and sequences of motor development, the therapist is forced to rely on clinical judgement rather than objective data to determine whether and to what extent delays or deficits exist. An assessment device designed to assess sensorimotor integration entitled Assessment or Sensorimotor Integration in Pre-School Children (see Appendix A) was developed for use with the pre-school age population in an attempt to remedy this problem.

Rationale

The vestibular system has been implicated in the development of body posture, muscle tone, ocular-motor control, reflex integration, and equilibrium reactions. Several studies have documented the influence of the vestibular system on extensor tone and body posture, and particularly upon the control of the neck musculature (Anderson, Soechting, & Terzuolo, 1977; Wilson & Maeda, 1974). The influence of vestibular stimulation on ocular-motor control has also been demonstrated by several studies. In one study of infants, vestibular-proprioceptive stimulation of the horizontal semi-circular canels that was provided in a horizontal or semi-vertical posture significantly enhanced visual pursuit behavior, while stimulation provided when the subjects were in stationary upright postures did not (Gregg, Haffner, & Korner, 1976). Gresty (1976) has also found that stimulation of the neck reflexes facilitates body orientation and the maximum use of the visual field.

Because the vestibular system is located at the junction of the two brain halves where neural tracts from all parts of the brain converge for processing it is hypothesized that the vestibular system may contribute to communication between the two brain hemispheres. Consequently, the coordination of the two body sides should be affected by dysfunctions of the vestibular system. That this is apparently the case was shown by Hamilton (1967) who found that "split-brain" monkeys failed to transfer objects from one hand to the other.

Recent research suggests that disorders in the vestibular system are correlated with learning disabilities in both motor behavior and language acquisition (DeQuiros, 1976). Ayres (1976) found that 50% of a group of children identified as learning disabiled also demonstrated inadequate vestibular functioning. Steinberg and Rendle-Short (1977) report that children with minor neurological dysfunction have a high proportion of deficits in postural reactions (particularly in the prone position), vestibular functions, and visual-spatial skills. Although most of the reported research has focused on learning disabiled children, in one study vestibular stimulation provided to normal and developmentally delayed infants for ten days resulted in significant improvements in the reflexes and motor behavior of the delayed subjects (Kanter, Clark, Allen, & Chase, 1976).

There is very little information in the literature regarding the development of postural control in pre-school children. One study (Shambes, 1976) compared the postural control of four and eight year old children using electromyography, center of gravity, and photographic procedures. The eight year olds had a higher degree of muscle localization with fewer extraneous body movements compared to the four year old group. Another study (Laurence & Kuypers, 1968) found that when the nerve tracts innervating the proximal muscles of the trunk and shoulder girdle are severed in monkeys, leaving nerve tracts innervating the distal arm and hand muscles intact, refined hand movements cannot be performed. (Stockmeyer (1967) has suggested that the progression of developments in postural control is closely related to the development of gross motor skills; however, there are no data available regarding the performance of pre-school children in this area.

In her studies of learning disabilities, Ayres (1974) has observed that the presence of primitive reflexes, and particularly the asymmetrical tonic neck reflex (ATNR) and tonic labyrinthine reflex (TLR), in conjunction with other signs, is associated with poor sensory integration in the brain. Although there have been few studies of primitive reflexes in normal individuals, it has been found that stressful activities can elicit the ATNR in the normal adult (Hellebrandt, Houtz, Partridge, & Walters, 1956). Parmenter (1975) measured the ATNR in normal first and third graders while they were in a hands-and-knees position. Visible changes in muscle tone with flexion of the skull side arm up to 30 degrees was found to be normal for children through eight years of age.

Ayres has developed a set of clinical observations which examine muscle tone, postural control, reflex integration, and rapid alternating movements of the hands and which are administered in conjunction with the Southern California Sensory Integration Tests (Ayres, 1972). No criteria are presented for scoring other than arbitrary definitions of normal responses and definite dysfunctions leaving the differentiation of responses falling between these extremes to the therapist's clinical judgement. Also, the items assessing supine flexion, prone extension, co-contraction, and the ATNR inhibiting posture are too difficlut for three-to-five year olds as they are usually unable to understand the concept of "holding" a complex body position. Ayres has also developed a test, the Southern California Postrotary Nystagmus Test (Ayres, 1975), which is designed to assess vestibular function. As there are no norms for three and four year olds, this test is of limited utility for assessing vestibular function in this age group.

The reflex tests most commonly used are Reflex Testing Methods for Evaluating C.N.S. Development (Fiorentino, 1973), Developmental Assessment: A Test for Gross Motor and Reflex Development (Hoskins & Squires, 1973), and Routine Developmental Examination in Normal and Retarded Children (Milani-Comparetti & Gidoni, 1967). Each of these tests evaluates primitive reflexes, righting reactions, and the maturation of equilibrium reactions in positions that are least stressful to the child. From the research cited earlier, it has been found that the primitive reflexes, and particularly the tonic neck and tonic labyrinthine reflexes, exist in varying degrees throughout the life span of normal individuals, and that they can be elicited under stressful body positions. Futhermore, children with developmental delays and deficits in sensorimotor integration demonstrate subtle signs of these abnormal reflexes moreso than do normal children.

Using only tests that are presently available, a child with poor postural control, poorly integrated reflexes, and poor bilateral motor integration may not be identified as having specific problems in these areas. Most likely treatment will be aimed at improving their fine and gross motor abilities when it should be directed instead towards a more basic level of intervention. Montgomery and Richter (1977) provided sensory integration therapy to retarded children and found that they made greater gains in their reflex integration, postural responses, and gross and fine motor skills than did a contrast group receiving gross motor instruction. The development of refined fine and gross motor skills depends upon good postural stability, integrated reflexes, and the well developed use of the two body sides. None of these vestibular-based functions are adequately assessed by any of the presently available measures, whether they are used singly or in combination.

Method

A measurement device entitled Assessment of Sensorimotor Integration in Pre-School Children (Appendix A) was developed to assess postural control, reflex integration, and bilateral motor integration in developmentally delayed children from three to five years of age. The test consists of 21 items, is administered individually, and can usually be given in a half hour. Since there is little empirical data available regarding the best ways to obtain reliable and valid measures in each of these areas, the test includes several items for each of the vestibular-based functions. The test items that measure postural control and bilateral motor integration are based primarily on developmental trends. Items that assess reflexes reflect research findings indicating that the tonic neck reflexes are most reliably tested in the quadraped position (Parmenter, 1975). The Schilder arm extension test with head rotation (Ayres, 1974) has been widely used for examination of the tonic neck reflex and was included here to examine the relationship of a child's performance on the Schilder to ATNR integration in the quadraped position. Table 1 on the following page summarizes the areas of sensorimotor integration that are assessed by each of the 21 items.

The scoring of each test item was made very specific to minimize the doubts that each examiner may have in rating a particular child on a specific item and to eliminate most examiner rating biases. Most of the

TABLE 1
TEST ITEM CONTENT

Item	Areas Assessed					
	Postural Control	Reflex Integration	Bilateral Motor Integration	Muscle Tone	Ocular-motor Control	Vestibular Function
Sit-up	X		X			
Muscle tone				X		
Neck flexion	X					
Monkey	X					
Prone on elbows, pegboard	X		X			
Co-contraction of neck	X					
Prone, rolling pin task	X					
Belly-crawling	X					
Wheelbarrow walk	X					
Airplane	X					
Scooter board, bilateral	X		X			
Scooter board, alternating			X			
ATNR integration		X				
STNR integration		X				
Quadruped, bat ball		X				
Tug of war	X				X	
Visual tracking						
Symmetrical hand movements			X			
Alternating hand movements			X			
Schilder arm extension		X				
Post Rotary Nystagmus						X

measures are objective, for example the number of seconds that a response occurs, the number of times that a response is repeated, etc., and are therefore relatively free of examiner errors and biases. The scores obtained for individual children are translated into a numerical rating scale which has successive intervals ranging from "abnormal" to "normal" or which indicate the degree to which a skill has been developed. Points are assigned to each choice so that indices of postural control, reflex integration, and bilateral motor control can be calculated.

Subjects. The test was administered[1] to a sample of normal children (N=113) with fairly equal numbers of male and female and black and white subjects. These results were then compared with data collected from a sample of white developmentally delayed children (N=23). Appendix A includes descriptive information about both groups of subjects.

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[1] A statement of assurance was submitted to the Johns Hopkins University Review Board on the Use of Human Subjects prior to the implementation of the project. The Board approved the project as being in compliance with the requirements for the protection of human subjects prescribed in Part 46 of Title 45 of the Code of Federal Regulations at its July 11, 1978 meeting. Parental consent forms were signed by the parents of all subjects in the study prior to their participation. A copy of the Review Board's approval document is included in Appendix B of this report.

To help insure that all of the nonhandicapped children tested were normal in their motor skills, a checklist (see Appendix C) of readily observed developmental milestones for the three-to-five year age range was sent, together with an informed consent form (see Appendix D), to the parents of potential subjects. This information was used to screen children with obvious delays from the normal sample. The children who were found to have possible delays on the checklist, or on the basis of subsequent testing, were further evaluated using the Koontz Child Development Program: Fine and Gross Motor Assessment (Koontz, 1974). A letter (Appendix E) was sent to the parents of children who were found to be normal in motor development on the basis of more comprehensive testing, while children who had documented delays of one or more years in either fine or gross motor skills were excluded from the normative sample. In this latter case the parents were notified with regard to the observed problems and where given selected activities for use with their children. Samples of these activities are included in Appendix F of this report.

The normal population consisted of both black and white subjects as prior research suggests that there may be racial differences in motor skill development in the pre-school years. A study of developmental levels in young children (Frankenburg, Dick, & Carland, 1975) found that black infants from lower socio-economic families were advanced in their motor skills until two years of age compared to a sample of white, black infants from lower socio-economic families were advanced in their motor skills until two years of age compared to a sample of white, middle class infants. However, after two years of age the black children showed a deceleration in development while the white children began to excel, especially in language, cognitive, and adaptive skills.

To assess the clinical usefulness of the assessment device, and to compare the performances of young handicapped children with their normal age-mates, the test was administered to 23 white developmentally delayed children who also ranged in age from three-to-five years. The subjects included in this group exhibited at least one year's delay in fine and/or gross motor development with cognitive functioning not lower than the mildly mentally retarded range. With the exception of four subjects, all of the children in this group received diagnostic testing at the Georgetown University Child Development Center in Washington, D.C. It was originally intended that at least 15 delayed children in each age group would be tested. However, difficulties were encountered in obtaining a sufficient number of subjects as the children in the day centers that were contacted had already received extensive testing.

Materials and procedures.

The test is administered individually and takes approximately one-half hour. The test is administered using a set of verbal directions which are specified for each test item. The child may be urged to continue performing an item until he reaches the point of fatigue or the maximum number of repetitions or seconds for the particular item.

Adequate space is required to administer the test to assure that the child does not stop in the middle of performing an item that requires repetitions (e.g. wheelbarrow walk). Most of the test materials are easily obtainable and include such items as a rolling pin, bean bags, and a large dowel. A scooter board, stopwatch, and rotation board for the post-rotary nystagmus test are the only major pieces of equipment that are needed.

Results and Discussion

Inter-rater reliability was obtained by computing the analysis of variance components between two tests given to 27 normal children at least one week apart by two different examiners. This method of determining inter-observer reliability is described by Berk (1979). The post-rotary nystagmus test was omitted from this analysis as an initial inspection of the data revealed that there was little agreement between observers on this measure. As one examiner was inexperienced in sensory integration testing, it appears that substantial training is necessary before this item can be reliabily used. One major revision was made in the scoring procedures to improve inter-observer agreement. On items measuring number of repetitions, it was necessary to place a ceiling on the performance level in order to prevent an inexperienced therapist from over-taxing a child's endurance. This ceiling affected only those children performing in the normal range.

The generalizability coefficient for a single observation is .837 which indicates a high average agreement between the two observers. The generalizability coefficient for two observations is .910, which estimates the average agreement between the two observers and a random theoretical sample from the same population.

The reliability for the test is felt to be significantly high, especially when the level of expertise of the two observers is considered. One examiner was a highly skilled occupational therapist with substantial experience in sensory integration testing. The other examiner was a new graduate in occupational therapy who had had no experience in pediatric testing. The use of experienced and inexperienced examiners suggests that an occupational or physical therapist with little or no experience in sensory integrative testing can use the assessment tool with good reliability.

An analysis of variance of the test scores for normal subjects failed to reveal any significant differences in performance attributable to age, sex, or race with the exception of (a) subtle differences in the performances of three year olds and five year olds on items measuring vestibular-based functions and (b) slightly higher scores for females than males. These differences were not large enough to warrant separate analyses.

Each item on the test was analyzed in terms of its mean score, discriminating power, and standard deviation. In addition, items were grouped by indices and optimal cutting scores were computed for each area which clearly differentiated the performance of normal and developmentally delayed children.

The analysis of the discriminating power for each item found that some items were better indicators of vestibular-based functions than others. In the area of postural control, stability in the prone-on elbows position and neck extension in the prone position were developmentally the most basic positions. Only those children with severe deficits had difficulty with these positions as shown by their rotating to a side-lying position when prone-on-elbows and by their holding their heads in neutral or with only slight extension when prone. That co-contraction is a developmentally more advanced skill than maintenance of anti-gravity postures was confirmed in the results of items testing co-contraction of the neck and arms. A progression was observed whereby those children in the upper range of normal functioning demonstrated the highest degree of co-contraction while children who had severe delays could not perform these items at all. An examination of extraneous trunk movements on both the scooter board and wheelbarrow walk items was found to be a poor indicator of postural control since there was an overlap in the performances of children who were low normal and those who were significantly delayed. The items examining refinements in postural control were found to discriminate only between children in the upper normal range and those in the low normal delayed ranges. These items include extension of the elbow in a wheelbarrow walk, absence of rotation in a sit-up item, and hip extension during two extension activities in the prone position. One item examined knee extension in prone activities on the scooter board; however, there was poor inter-observer reliability on this item and it was discarded.

In the area of reflex integration the tonic neck reflexes in the quadraped position were found to be the best indicators of integrated function. Only children with severe deficits collapsed on the skull side arm when the asymmetrical tonic neck reflex was elicited in quadraped with all other children showing 30 to 60 degrees of flexion of the skull side arm on this item. Resistance of the head was also observed and showed a progression with severely delayed children having severe head resistance, children in the low normal range or those having slight delays demonstrating slight to moderate resistance, and children in the upper normal range having no resistance of the head. When the symmetrical tonic neck reflex (STNR) was elicited in the quadraped position, only those children with severe delays had definite joint changes in flexion or extension. This reflex was also tested by having the subjects lift one arm while they were on their hands and knees. Balance appeared to enter into this task, however, with the result that findings on this item are useful only when they are considered in relation to the examination of the STNR in a stable quadraped position. The Schilder arm extension test was administered with head rotation and was found to be less precise as an indicator of reflex integration than were the tonic neck reflexes in quadraped. This finding is supported by a recent study by Sieg and Schuster (1979). Head resistance and steadiness of the arms on this item showed differences between the normal and delayed samples. Trunk rotation was also examined with this time with only those children in the upper range of normal functioning failing to show any trunk rotation.

In the area of bilateral motor integration, symmetrical grasp patterns measured in the rolling pin activity and the ability to cross the body midline or transfer to a preferred hand were identified as the most basic skills. Only children with severe delays could not either maintain a symmetrical grasp or cross the body midline, and showed a strong tendency to use the hand that was closest to the object. These findings support the position that hand dominance is usually established during the pre-school years. A progression was demonstrated in all tasks requiring bilateral symmetrical and alternating movements such as drumming rhythms or pushing on a scooter board while prone. Symmetry of hand movements was observed primarily in children in the upper normal range. Eye-hand dominance was also assessed but, when it was found that eye-hand agreement does not occur in normal children during the pre-school years, the item was discarded.

Muscle tone was assessed since the vestibular system affects muscle tonus. All children in the normal group had normal muscle tone with the exception of a few children who had slight hypotonia. All of the children in the developmentally delayed population had slight to severe hypotonia.

Ocular-motor control was also included in the assessment as it is also a vestibular-based function. An interesting finding was that vertical tracking was found to be more primal than horizontal tracking as a substantial number of children in the low normal range had a midline jump when tracking in the horizontal plan whereas all children, except those with severe delays; showed smooth tracking in the vertical plane.

Dissemination

An initial report on the development and use of the assessment device described above was given by Georgia DeGangi in a paper titled "Assessment of Postural Control, Reflex Integration, and Bilateral Motor Coordination in Young Handicapped Children" presented at the annual meeting of the American Association on Mental Deficiency held in late May, 1979 in Miami, Florida.

A copy of the test manual (Appendix A) and a validation questionnaire was sent to 20 selected occupational therapists for their review and comments. The validation questionnaire is included as Appendix G of this report. A list of the participating therapists includes:

Billie McKae, OTR
Accotink Academy
Springfield, VA

Helen Conge, OTR
Child Development Center of
Northern Virginia
Falls Church, VA

Susan Schaeffer, OTR
Children's Hospital
Washington, DC

Delores Arroyo, OTR
Christ Church Child Center
Bethesda, MD

Cindy Garreleck, OTR
Handicapped and Crippled
Children's Clinic
Washington, DC

Charlotte Exner, OTR
Kennedy Institute
Baltimore, MD

Theresa Solmesson, OTR
National Institutes of
Health
Bethesda, MD

Barbara Bassin, OTR
Prince Georges County
Health Department
Cheverly, MD

JoAnn Kennedy, OTR
D.C. Society for Crippled Children
Washington, DC

Trudy Deitchman, OTR
Easter Seal Treatment Center
Rockville, MD

Carol Wiley, OTR
Fairfax Hospital
Falls Church, VA

Virginia Balserak, OTR
Fairhill Center School
Fairfax, VA

Ruth Strauss, OTR
Hospital for Sick Children
Washington, DC

Patricia Komich, OTR
Kennedy Center
Denver, Colorado

Jan Olsen, OTR
Montgomery County Public Schools
Rockville, MD

Lynne Gardner, OTR
Prince Williams County
Public Schools
Mannassas, VA

Karen Szatalowicz, OTR
Riley Hospital
Indianapolis, Indiana

Kathleen Swenson Miller, OTR
University of North Carolina
Chapel Hill, NC

Dorothy Marsh, OTR
Private Practice
Potomac, MD

Nina Love, OTR
Resurrection Preschool
Arlington, VA

In summary of the questionnaire responses submitted by the cooperating therapists, most reported that they found the test to be useful for three to five year olds who had gross and fine motor delays, learning disabilities, hypotonic cerebral palsy, and mild to moderate mental retardation. Some of the therapists reported that they were able to use the test with older children but that they had difficulty with the items that required lifting the child. They reported, however, that they were able to readily adapt these items for their own purposes. The test was reported to be of limited utility with severely retarded, severely emotionally disturbed, and spastic or athetoid cerebral palsied children. It should be pointed out, however, that the test was not designed for use with these populations and was not expected to be useful with them. The therapists also found that the test items were easy to administer although several pointed out that further clarification was needed with regard to scoring and interpreting certain items. They generally felt that the three areas (postural control, reflex integration, and bilateral motor coordination) were accurately assessed but only when the entire test was administered as some of the items are not as good indicators as are others. The therapists found it easy to relate the child's areas of need to treatment goals and activities. In the section of the manual that presents statistical analyses of the data, some of the therapists reported difficulty in understanding the data. The major criticism that was received was that the test needed to be standardized so that the performance levels of three and five year olds could be differentiated. Some of the therapists further reported that items measuring tactile perception and motor planning skills should be added to the test.

Copies of the test manual have also been sent upon request to individual therapists and to centers serving handicapped children. These requests were received as a result of the AAMD presentation mentioned above and in response to an announcement of the test's availability that appeared in the June, 1979 issue of Newsletter of the American Occupational Therapy Association. The individuals and centers receiving copies of the manual to date include:

Pat Nuse Clark, OTR	Decatur, Georgia
Jefferson County Community Center	Arvada, Colorado
Los Ninos Center	SanDiego, California
Morton Plan Hospital	Clearwater, Florida
Taylor Rehabilitation Center	Cedar Rapids, Iowa
Johns Hopkins University	Baltimore, Maryland
Carol Linsford, OTR	Lexington, Kentucky
Helen Neville, OTR	Annapolis, MD
Dorothy Mount, OTR	Long Beach, California
Dorothy Jirgel, OTR	Del Mar, California
Lynn Urban, OTR	Goleta, California
Karen Hartman, OTR	Grand Junction, Colorado

Marjorie Paller, OTR	Denver, Colorado
Ann Viviano, OTR	Greeley, Colorado
Judy Voltzow, OTR	Seminole, Florida
Donna Cadiz, OTR	Pearl City, Hawaii
Kathryn Bouma, OTR	Chicago. Illinois
Joan Tunningley, OTR	Mount Prospect, Illinois
Terry Milligan, OTR	Woodstock, Illinois
Pat Linden, OTR	Cedar Rapids, Iowa
Margo Groteguth, OTR	Baton Rouge, Louisiana
Pamela Lemerand, OTR	Northville, Michigan
Marla Gousseff, OTR	Ypsilante, Michigan
Sandy Bell, OTR	Powagrac, Michigan
Tonya Soules, OTR	St. Paul, Minnesota
Anita Bundy, OTR	Attleboro, Massachussetts
Mary-Margaret Windsor, OTR	Dover, New Hampshire
Rhoda Erhardt, OTR	Fargo, North Dakota
Alexian Brothers Medical Center	Elk Grove, Illinois
Blythesdale Children's Hospital	Valhalla, New York
Bona Vista Program	Kokomo, Indiana
Children's Hospital	Akron, Ohio
Children's Specialized Hospital	Westfield-Mountainside, N.J.
Edmonton Assoc. for Mentally Retardation	Alberta, Canada
Easter Seal Assoc. for the Crippled	Elgin, Illinois

Handicapped Children's Assn. of Souther N.Y.	Johnson City, N.Y.
Hospital for Sick Children	Toronto, Canada
Institute of Logopedics	Witchita, Kansas
Lord Baden Powell Orthopedic Unit	Anaheim, California
Memorial Hospital	Sarasota, Florida
Northwestern Illinois Assn.	Geneva, Illinois Eileen Bushell, OTR
Newington Children's Hospital	Newington, Conn.
Ohio State Univ.	Columbus, Ohio
Publis School of City of Muskegan	Muskegan, Michigan
Prince Williams County Public Schools	Manassa, VA
Prince Georges County Public Schools	Cheverly, MD
Rock Creek Diagnostic Center	Frederick, MD
Society for Crippled Children	Cleveland, Ohio
Special Ed. Dist: of Lake Co. - Mc Henry Regional Program	Libertyville, Fla.
St. Jude Center	Juneau, Alaska
St. Paul Rehabilitation Center	St. Paul, Minn.
Texas Children's Hospital	Houston, Texas
Univ. of Va., Children's Rehab. Center	Charlotesville, Va.
Univ. of Montreal, Occupational Therapy Sch.	Quebec, Canada

United Cerebral Palsy	Brooklyn, N.Y.
United Cerebral Palsy	Syracuse, N.Y.
Univ. of Minnesota (O.T. School)	Minneapolis, Mirn.
Univ. of Alabama (O.T. School)	Birmingham, Ala.
Univ. of Florida (O.T. School)	Gainesville, Fla.
Univ. of Iowa (O.T. School)	Iowa City, Iowa
Wilcox Pearkes Clinic	Victoria, British Columbia
Weld County Community Center Foundation, Inc.	Greeley, Colorado
Ventura Co. Community on Human Concerns and Community Development	Ventura, Calif.
Easter Seal Assn.	Elgin, Illinois
Pleasant Hill Developmental Center	Marshalltown, Iowa
United Cerebral Palsy	Staten Island, N.Y.
Univ. of North Carolina	Chapel Hill, N.C.
Alief Indenpendent School District	Alief, Texas
WETP, Inc.	Marysville, Washington
Special Educatiln Program	Wlmwood, Wisconsin
The Community Hospital Group, Inc.	Edison, N.J.
Georgetown Univ. Child Dev. Cntr.	Washington, DC

A journal article that includes much of the information contained in this report is also being prepared for submission to the American Journal of Occupational Therapy.

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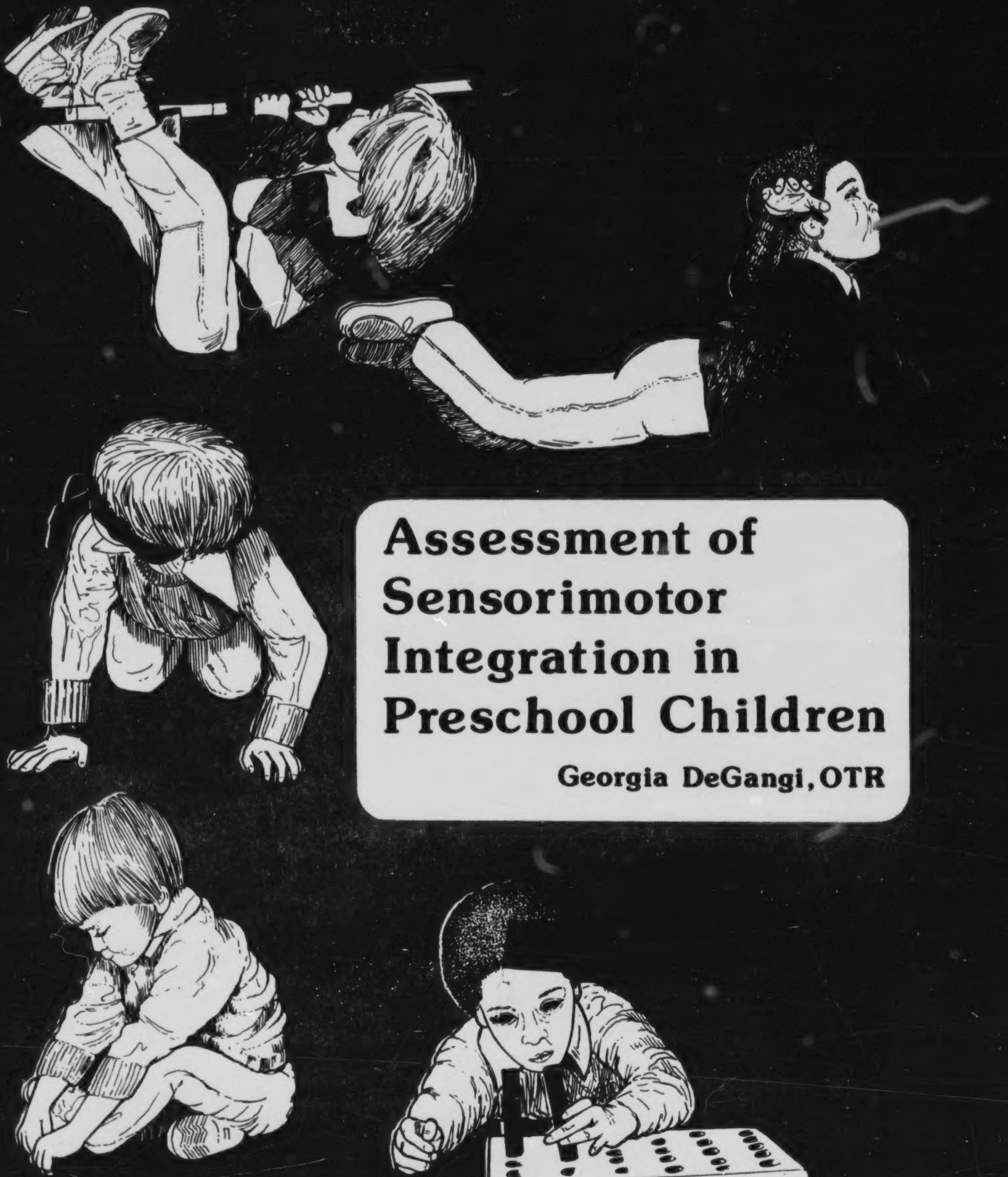
Appendix A

Manual for the Assessment of Sensorimotor Integration in Preschool Children



Assessment of Sensorimotor Integration in Preschool Children

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Assessment of Sensori-motor Integration in Pre-School Children

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Introduction

Early intervention is of the utmost importance for developmentally delayed children in light of the "plasticity" of the young child's central nervous system. Ayres (1972) and Dobbing (1975) have both stressed that the capacity of the nervous system to gradually adapt and become reorganized in response to sensorimotor experience diminishes with age. According to Ayres:

> Since the plastic capacity diminishes with maturation, the longer the delay in employing sensorimotor experience to modify the interconnections of the functional system of the brain, the harder it is to modify the maturational process. Neurological organization is virtually completed within the first decade of life. (pp. 16-17)

Effective early intervention services are necessarily predicated on the prior identification of developmental delays, and many delayed children are denied the benefit of these services because they are not identified during the preschool period. Evidence of some children's developmental problems can be observed in relatively major deficits in gross and fine motor skills that occur in the first few years of life. However, less pronounced sensorimotor dysfunctions are often unrecognized until the school years, when moderate to severe learning disabilities appear, because our measurement devices are unable to detect the more subtle indicators of sensorimotor integration. In the absence of standardized testing procedures that are based on the normal patterns and sequences of motor development, the therapist is forced to rely on clinical judgment rather than objective data to determine whether and to what extent delays or deficits exist. The assessment device presented in this manual, although intended as a preliminary study, is designed to remedy this problem by providing an accurate,criterion-referenced indicator of delays in sensorimotor integration which can serve as a basis for therapeutic intervention with developmentally delayed children. The test has been designed specifically for use by physical therapists, occupational therapists, and other professionals who have had sufficient training in sensorimotor integration to permit them to interpret test scores and to develop appropriate intervention activities based on test information.

A review of the available literature in sensorimotor integration (see Appendix A) indicated that developments in postural control, reflex integration, bilateral motor coordination, and vestibular functioning are prerequisite to later refinements in gross motor, fine motor, and perceptual motor skills. The 21 items that comprise the test were selected to measure developmental progress in these four domains. Thus the test should prove to be useful with a variety of developmental and learning disabilities. It should be noted, however, that many of the test items require that the child follow simple directions and are therefore inappropriate for use with severely or profoundly mentally retarded children. However, the test items that do not require verbal instructions can be administered to this population. Although the test was designed for the three-five year age group, in some cases the therapist may use it with children who are over five years of age but who are functioning in the three to five year range in terms of sensorimotor integration.

The test was designed to correlate with developmental activities that might be prescribed in the areas of postural control, reflex integration, and bilateral motor integration. The effectiveness of procedures designed to facilitate sensorimotor integration has been compared to the alternative of programs that focus exclusively on specific gross motor skills. Montgomery and Richter (1977) found that retarded children receiving sensory integration training made greater gains in their reflex integration, postural responses, and gross and fine motor skills than did a contrast group receiving gross motor instruction. These authors have also developed a handbook for use by therapists titled Sensorimotor integration for developmental disabled children: A handbook (Montgomery & Richter, 1978) that can be used for prescriptive programming that is based on assessment information. After a child has participated in a sensorimotor integration treatment program, the test can be readministered to measure the child's progress and treatment program effects.

Test Construction

Item Selection and Sequencing

There is little empirical data available regarding the best ways to obtain reliable and valid measures of postural control, reflex integration, and bilateral motor integration in young children. For this reason, several test items assessing each of these functions were devised. The test items that measure postural control and bilateral motor integration are based primarily on developmental trends. The items that assess reflexes reflect research findings indicating that the tonic neck reflexes are most reliably tested in the quadruped position (Parmenter, 1975). The Schilder arm extension test with head rotation (Ayres, 1972) has been widely used for examination of the tonic neck reflex but, because of the lack of data on the performance of children on this measure, it was included to examine the relation to ATNR integration in the quadruped position.

The test is comprised of 21 items and takes about 30 minutes to administer to an individual child. The test items are sequenced according to difficulty or stressfulness and ease of administration rather than in terms of developmental progression.

In several instances a single test item has several scoring criteria to discriminate the different functions that it serves. Table 1 summarizes the areas of sensorimotor integration that are assessed by each of the 21 items.

TABLE 1
TEST ITEM CONTENT

Number	Item	Areas Assessed					
		Postural Control	Reflex Integration	Bilateral Motor Integration	Muscle Tone	Ocular-motor Control	Vestibular Function
1	Sit-up	X		X			
2	Muscle tone				X		
3	Neck flexion	X					
4	Monkey	X					
5	Prone on elbows, pegboard	X		X			
6	Co-contraction of neck	X					
7	Prone, rolling pin task	X					
8	Belly-crawling	X					
9	Wheelbarrow walk	X					
10	Airplane	X					
11	Scooter board, bilateral	X		X			
12	Scooter board, alternating			X			
13	ATNR integration		X				
14	STNR integration		X				
15	Quadruped, bat ball		X				
16	Tug of war	X				X	
17	Visual tracking						
18	Symmetrical hand movements			X			
19	Alternating hand movements			X			
20	Schilder arm extension		X				
21	Post Rotary Nystagmus						X

Scoring

Scoring criteria for the items were made very specific, both to minimize the doubts that each examiner may have in rating a particular child on a specific item and to eliminate most examiner rating biases. Many of the measures are objective, for example, the number of seconds that a behavior occurs, the number of responses emitted, etc., and are therefore relatively free of examiner errors and biases.

The scores obtained for individual children are translated into a numerical rating scale which has successive intervals ranging from abnormal to normal responses or which indicate the degree to which a skill has been developed. Points are assigned for each choice so that indices for postural control, reflex integration, bilateral motor integration, and vestibular function can be calculated.

Test Administration

Before administering the test, the examiner should become familiar with the test procedures and scoring criteria. When administering the test, the examiner should urge the child to perform until he reaches the point of fatigue or the maximum number of repetitions or seconds for the particular item.

Setting. Adequate space is required to administer the test to assure that the child does not need to stop in the middle of performing an item that requires repetitions, e.g. the wheelbarrow walk or the scooter board push. As a general rule, an open space of approximately 20 ft. by 20 ft. is adequate. The setting in which the test is administered should also be free from distractions.

Equipment: The following equipment items are needed to administer the test:

One red yarn ball suspended on a string.

One large coffee can.

Ten standard size bean bags.

One dowel (3 feet long x 3/4 inch diameter).

One pegboard and ten 1/2 inch pegs (approximate dimensions 12" x 12" size board).

One standard size scooter board (Fuzzy-Wuzzy Scooter Board from Fred Sammons, Inc.).

One blindfold scarf.

One six foot length of rope, 1/2 inch diameter.

One rotation board (Western Psychological Services: Southern California Post-Rotary Nystagmus Test Board).

One mat.

One low table.

One rolling pin, standard size (approximately 2" diameter).

One stopwatch.

One ball, any size.

An interesting visual target affixed on the wall.

Test Reliability

Reliability of measurement was obtained by computing the analysis of variance components between two tests given at least one week apart by two different examiners on 27 normal children. This method of determining inter-observer reliability is described by Berk (1979). The generalizability coefficient for a single observation is .837 which indicates a high average agreement between one observer and another. The generalizability coefficient for two observations is .910, an estimate of the average agreement between the two observers and a random theoretical sample from the same population. (See Table 3)

The reliability for the test is felt to be significantly high, especially when the level of expertise of the two observers is considered. One examiner was a highly skilled occupational therapist with much experience in sensory integration testing. The other examiner was a new graduate in occupational therapy and had no experience in pediatric tests. This wide difference in observer experience was intended so that an occupational or physical therapist with little to no experience in sensory integrative testing could use the assessment tool with good reliability. It is, however, recommended that the therapist practice the items before administering the test on a child.

Inter-rater reliability was computed for all test items except the post-rotary nystagmus test where little agreement was found between observers. As one examiner had no previous experience in sensory integrative testing, it can be ascertained that this item requires much practice in administration before good reliability can be attained.

One major revision was made in the scoring procedures to improve inter-observer agreement. In items measuring number of repetitions, it was necessary to place a ceiling on the performance level in order to prevent an inexperienced therapist from over-taxing the child's endurance.

TABLE 2
RATINGS OF 27 NORMAL CHILDREN BY TWO OBSERVERS

	Observer			
Child	1	2	(ΣX_p)	$(\Sigma X_p)^2$
1	88	89	177	31329
2	66	67	133	17689
3	79	85	164	26896
4	75	81	156	24336
5	75	74	149	22201
6	78	65	143	20449
7	82	87	169	28561
8	85	85	170	28900
9	86	85	171	29241
10	72	82	154	23716
11	81	75	156	24336
12	81	75	156	24336
13	93	82	175	30625
14	76	84	160	25600
15	69	66	135	18225
16	84	78	162	26244
17	87	86	173	29929
18	77	84	161	25921
19	63	74	137	18769
20	65	74	139	19321
21	81	85	166	27556
22	86	92	178	31684
23	61	62	123	15129
24	85	89	174	30276
25	80	77	157	24649
26	81	89	170	28900
27	83	85	168	28224
X_o	2119	2157	4276	683042
$(\Sigma X_o)^2$	4490161	4652649	9142810	
X^2	342056			

TABLE 3

COMPUTATION OF ANALYSIS VARIANCE COMPONENTS
FOR ESTIMATING INTEROBSERVER RELIABILITY ACROSS TWO PERSONS

Source of Variation	SS	df	MS	2
Between persons	2925.15	26	112.50	51.55
Within persons				
Between observers	26.74	1	26.74	.642
Residual	508.26	26	9.412	9.412
Total	3460.15	53		

Test Validation

The test was validated by administering it to a sample of normal children (N=113). These results were then compared with test data collected from a sample of developmentally delayed children (N=23). The procedures that were used to collect the data are described below.

Normal Subjects:

The test data is based on a sample of 113 normal children ranging in age from 3 to 5 years. To help insure that all the children tested were normal in their motor skills, a questionnaire was completed by their parents prior to testing that included questions about any concerns the parents may have had about their child's motor development as well as a brief checklist of esily observed developmental milestones within the three to five year age range. The questionnaire completed by the parents is reproduced in Appendix B of this manual. This information was used to screen children with obvious delays or handicaps from the sample. The children who were found to have possible delays on the test itself were further evaluated with the Koontz Child Development Program: Fine and Gross Motor Assessment (1974). Children with documented delays of one year or more in either gross or fine motor development were excluded from the normative sample.

It was originally planned that equal numbers of male and female subjects in each age group (three, four, and five year olds) would contribute data to the study. However, this was not possible due to time restrictions placed on the project.

The normative sample consisted of both black and white subjects. Most of the children in the white sample attended preschools in Arlington and Falls Church, Virginia. The participating nurseries included the Chesterbrook Montessori School, the Montessori Children's House of Falls Church, and Yorktowne Square Day School. Most of the subjects in the sample of black children attended preschools in Washington, D.C. The participating nurseries included the Matthews Memorial Baptist Nursery School, Sojourner's Day Care Center, and the Columbia Heights Day Care Center. These two socio-ethnic groups were included in the study because of studies indicating that they may show differences in motor skill development in the pre-school years. A study of developmental levels in young children (Frankenburg, Dick & Carland, 1975) found that black infants from lower socio-economic families were more advanced in their motor skills until two years of age compared to a sample of white, middle class infants. This was attributed to differences in child rearing practices. The black infants were allowed more independence at an early age while the white families were more protective of their infants. After two years of age, however, the black children showed a deceleration in their advanced development while the white children began to excel, especially in language, cognitive, and adaptive skills.

The age, sex, and race composition of the sample of normal subjects is shown in Table 4.

TABLE 4
CHARACTERISTICS OF NORMAL SUBJECT SAMPLE

	Black Subjects		White Subjects		
Age Group	Males	Females	Males	Females	Total
3 year olds	9	14	9	9	41
4 year olds	8	14	14	10	46
5 year olds	9	4	5	8	26
Total	26	32	28	27	113

Of the 113 subjects in the normal sample, ten were found to have possible motor delays on the basis of the parent questionnaire. None of them were delayed as much as one year in either fine motor or gross motor development, however, and were therefore included in the normative sample. Four children who were tested were found to have definite motor delays; consequently, their test results contributed data to the study of developmentally delayed children described below.

Developmentally Delayed Subjects

In order to assess the clinical usefulness of the assessment device, and to compare the performances of young handicapped children with their normal age-mates, the test was administered to 23 white, developmentally delayed children who also ranged in age from three to five years. The subjects included in this group exhibited at least one year's delay in fine and/or gross motor development with cognitive functioning not lower than the mildly mentally retarded range. It was originally planned to test at least 15 children in each age group; however, all but one of the centers for handicapped children contacted in this regard declined participation as they reported that their children had already received extensive testing. Table 5 describes the composition of the delayed subject sample.

TABLE 5
CHARACTERISTICS OF DELAYED SUBJECT SAMPLE

Age Group	Males	Females	Total
3 year olds	3	0	3
4 year olds	8	2	10
5 year olds	7	3	10
Total	18	5	23

With the exception of the four subjects included in this sample who were attending preschool programs for normal children, all of the delayed children were tested at the Georgetown University Child Development Center in Washington, D.C. The Center provides interdisciplinary diagnostic services so each subject received a comprehensive evaluation by the departments of pediatrics, psychology, speech and language, and occupational and physical therapy. Table 6 describes the developmental disabilities represented in the sample of delayed children.

TABLE 6
DISABILITIES REPRESENTED IN THE DELAYED SUBJECT SAMPLE

Disability	Number of Children	Comments
Seizure Disorder	9	All controlled by medication.
Language Delay 1-2 years	12	None were hearing impaired. One child had cleft palate. All functioned at the two year level or above.
Mild Mental Retardation	4	19 subjects had IQs that were within the normal range.
Fine Motor Delay 1 year	20	All functioned at the two year level or above.
Gross Motor Delay 1 year	16	All functioned at the two year level or above.
Behavior Problems	4	
Autistic-like Characteristics	2	
Cerebral Palsy	1	Diagnosed as severe hypotonia.

Test Revisions

Several of the original test items were revised or discarded after item analysis was performed. Table 7 compares the data from the normal and developmentally delayed groups and reflects decisions on item selection based on item discrimination.

Initially the test was designed to include hand preference in stressful activities (e.g. item #1: sit-up; item #5: prone on elbows, pegboard activity; and item #15: quadruped, bat ball). After item analysis, it was found that items #1b-e and 5b-e only discriminated those children with severe midline integration problems who use the hand closest to the object without crossing the midline or transferring to a preferred hand. For this reason, the scoring on these items was simplified to identify those children with severe deficits. Since item #15b-c did not discriminate between the normal and developmentally delayed groups, the item was discarded. Eye-hand dominance was further examined in item #17 in a task requiring the child to look through a tube. Discrimination was found to be poor in this item, therefore it can be inferred that eye-hand agreement is not a good indicator of lateralization and consequently, the item was discarded.

Poor discrimination was also found in item #9b which examined the hand position in the wheelbarrow walk. Most children could perform this task with an open hand. Another item with low discrimination was #16b which tested the alternation of hands in a tug of war. A high percentage of both groups of children tested could perform this task easily. Both of these items were therefore discarded. Poor inter-rater reliability was found in item #11d, a scooter board task where knee position was observed. In addition, no differences were found between items #11e and 12b, both scooter board activities, one where the arms are pushing symmetrically and the other in alternating movements, in which extraneous movements were observed. The second item was discarded to consolidate the test.

Although there is no data available on the post-rotary nystagmus test because of poor inter-rater reliability, the item was not discarded in order to provide procedures and scoring criteria for use in comparison with other vestibular-based functions on the test.

TABLE 7
ITEM SELECTION

ORIGINAL TEST ITEMS	NORMAL GROUP MEAN DIFF.	D.D. GROUP MEAN DIFF.	DISC.	ITEM STATUS*
1. Sit-up:				
a. Number of sit-ups	2.0	1.45	.55	
b. Crosses midline with right hand	.59	.09	.50	Revise
c. Crosses midline with left hand	.21	.23	.02	Revise
d. Transfers to right hand	.53	.36	.17	Revise
e. Transfers to left hand	.38	.09	.29	Revise
f. Amount of rotation	.12	.00	.12	
2. Muscle tone:				
a. Right	1.89	.73	1.16	
b. Left	1.91	.73	1.18	
3. Neck Flexion:				
a. Number of repetitions	2.48	.91	1.57	
4. Monkey:				
a. Ability to hold position	2.64	1.50	1.14	
b. Number of seconds held	1.83	.86	.97	
5. Prone on elbows, pegboard:				
a. Body position during task	.97	.64	.33	
b. Crosses midline with right hand	.67	.41	.26	Revise
c. Crosses midline with left hand	.18	.14	.04	Revise
d. Transfers to right hand	.11	.27	.16	Revise
e. Transfers to left hand	.06	.09	.03	Revise
6. Co-contraction of neck:				
a. Head position during task	.95	.64	.31	
b. Amount of resistance	.97	.41	.56	
c. Number of seconds held	1.69	.64	1.05	
7. Prone, rolling pin task:				
a. Maintains grasp on handles	.98	.64	.34	
b. Number of times lifted up	2.75	1.0	1.75	
c. Position of hips	.91	.14	.77	
d. Position of head	.99	.59	.40	
8. Belly-crawling:				
a. Amount of rotation	.85	.59	.26	
b. Number of steps	3.18	1.55	1.63	

ORIGINAL TEST ITEMS	NORMAL GROUP MEAN DIFF.	D.D. GROUP MEAN DIFF.	DISC.	ITEM STATUS*
9. Wheelbarrow walk:				
a. Head position	.93	.73	.20	
b. Hand position	1.0	.86	.14	Discard
c. Elbow position	.78	.14	.64	
d. Amount of extraneous movements	.85	.45	.40	
e. Number of steps	3.48	1.36	2.12	
10. Airplane:				
a. Placement of support	1.62	1.05	.57	
b. Symmetrical posture of arms	.71	.41	.30	
c. Number of seconds	1.98	1.36	.62	
11. Scooter board, bilateral symmetrical movements:				
a. Head position	.89	.45	.44	
b. Shoulder girdle	.75	.36	.39	
c. Hip position	.51	.05	.46	
d. Knee position	.66	.09	.57	
e. Amount of extraneous movements	.87	.27	.60	
f. Number of steps	2.85	1.73	1.12	
12. Scooter board, reciprocal alternating movements:				
a. Number of steps	2.56	1.05	1.51	
b. Amount of extraneous movements	.65	.09	.56	
13. ATNR Integration:				
a. Degree of resistance of head to right	1.63	.77	.86	
b. Flexion of skull-side arm, right side	1.25	.77	.48	
c. Degree of resistance of head to left	1.64	.77	.87	
d. Flexion of skull-side arm, left side	1.33	.77	.56	
14. STNR Integration:				
a. Body position upon head flexion	1.57	1.23	.34	
b. Body position upon head extension	.93	.45	.48	

ORIGINAL TEST ITEMS	NORMAL GROUP MEAN DIFF.	D.D. GROUP MEAN DIFF.	DISC.	ITEM STATUS*
15. Quadruped, bat ball:				
a. Maintenance of quadruped position	.89	.27	.62	
b. Crosses midline with right arm	.52	.45	.07	Discard
c. Crosses midline with left arm	.31	.14	.17	Discard
16. Tug of war:				
a. Amount of resistance applied	1.54	1.0	.54	
b. Alternation of hands	.99	.82	.17	Discard
17. Hand/Eye Dominance:				
a. Number of times right hand used	2.34	1.77	.57	Discard
b. Number times left hand used	.80	1.09	.19	Discard
c. Number times right eye used	1.64	1.59	.05	Discard
d. Number times left eye used	1.38	1.09	.19	Discard
e. Hand/eye agreement	.62	.59	.03	Discard
18. Visual tracking:				
a. Smoothness of tracking in horizontal plane	1.76	.82	.94	
b. Smoothness of tracking in vertical plane	.95	.27	.68	
19. Symmetrical hand movements:				
a. Number of repetitions in 10 seconds	2.93	2.14	.79	
b. Symmetry of movements	.83	.23	.60	
20. Alternating hand movements:				
a. Number of drumming pairs in 10 seconds	2.85	1.91	.94	
b. Steadiness of rhythm	.81	.18	.63	
21. Schilder Arm Extension test with Head Rotation:				
a. Resistance of head to turning	.84	.23	.61	
b. Steadiness of arms	1.03	.27	.76	
c. Rotation of arms and trunk	.36	.05	.31	

*All items accepted except those indicated.

Data Analysis

Data was analyzed with comparisons made between 113 normal three to five year olds of both black and white races and 23 white developmentally delayed children of the same age range. Differentiation in age, sex, and race was not significant enough to consider each sub-group independently for analysis. Generally females performed slightly better than males. Race differences were not consistant, however, in many cases the following trend was noted although differences in performance levels were minimal: white females performed in the upper range followed by black females, then black males and lastly white males. Very subtle differences were observed across age levels.

Individual items were analyzed in terms of mean and standard deviations. Standard scores were calculated using both normal and developmentally delayed groups to define expected performance levels for the upper and lower ranges of normal, and slight to significant and severely delayed children. Individual item analysis is presented in Table 8 for use by occupational and physical therapists who cannot administer the test in its entirety to a particular child. When this is the case, scoresheet 2 should be used to determine the child's level of function.

In addition to individual item analysis, indices in the areas of postural control which includes flexion and extension responses, tonic labyrinthine reflex integration (the composite of all postural control items), co-contraction, tonic neck reflex integration, and bilateral motor integration were computed. Optimal cutting scores were determined for each area after comparison of the normal and developmentally delayed group data. Standard scores were used to further differentiate upper and lower ranges of normal and slight to significant and severely delayed children after cutting scores were taken into account. Table 9 reflects these scores. Since there was no overlap in performance ranges of normal and developmentally delayed groups when determining the optimal cutting scores, the probability of a correct decision regarding the child's level of functioning would then be 100% with 0% probability of Type I and II errors. This provides specific data to determine the validity of the test in classifying master and non-master performance. Weighted cutting scores were not of value in this test as there was no reason to alter the optimal cutting score since each group was accurately classified. When scoring an individual child's performance, it is preferrable to utilize the indices in Table 9 since the probability of a correct decision would be less when using individual item analysis (Table 8). Scoresheet I should be utilized for children who can complete the entire test.

TABLE 8
INDIVIDUAL ITEM ANALYSIS

	NORMAL CHILDREN		DELAYED CHILDREN		SCORE INTERPRETATION			
Item	Mean	SD	Mean	SD	Upper Range of Normal	Lower Range of Normal	Slightly to significantly Delayed	Severely Delayed
1a. # Sit-ups	2.0	0	1.45	.6	2	2	2	0,1
1b. Sit-ups: hand use	.59	.49	.36	.49	1	1	1	0
1c. Sit-ups: Rotation	.12	.32	0	0	1	0	0	0
2. Muscle tone: Left and Right	1.9	.34	.73	.63	2	1,2	1	0
3. Neck flexion	2.48	.68	.91	.75	3	2	1	0
4a. Monkey position	2.64	.63	1.5	.91	3	2	1	0,1
4b. Monkey: # seconds	1.83	.4	.86	.83	2	1	1	0
5a. Prone on elbows: position	.97	.18	.64	.49	1	1	1	0
5b. Prone on elbows: hand use	.67	.47	.41	.50	1	0,1	0,1	0
6a. Co-contraction: head position	.95	.22	.64	.49	1	1	1	0
6b. Co-contraction: resistance	.97	.4	.41	.5	1	0,1	0,1	0
6c. Co-contraction: # seconds	1.69	.57	.64	.79	2	1	1	0
7a. Rolling pin: grasp	.98	.14	.64	.49	1	1	1	0
7b. Rolling pin: # lifts	2.75	.56	1.0	.93	3	2	1,2	0
7c. Rolling pin: hip position	.91	.33	.14	.35	1	0,1	0	0
7d. Rolling pin: head position	.99	.10	.59	.50	1	1	0,1	0
8a. Belly crawl: rotation	.85	.36	.59	.50	1	0,1	0,1	0
8b. Belly crawl: # steps	3.18	.98	1.55	1.18	3,4	2,3	1,2	0,1
9a. Wheelbarrow: head position	.93	.26	.73	.46	1	1	1	0
9b. Wheelbarrow: elbow position	.78	.42	.14	.35	1	0	0	0
9c. Wheelbarrow: extraneous movements	.85	.36	.45	.51	1	0,1	0,1	0
9d. Wheelbarrow: # steps	3.48	.63	1.36	.9	3,4	3	1,2	0,1

INDIVIDUAL ITEM ANALYSIS

Item	NORMAL CHILDREN		DELAYED CHILDREN		SCORE INTERPRETATION			
	Mean	SD	Mean	SD	Upper Range of Normal	Lower Range of Normal	Slightly to significantly Delayed	Severely Delayed
10a. Airplane: support	1.62	.53	1.05	.72	2	1	1	0
10b. Airplane: symmetry of arms	.71	.52	.41	.50	1	0,1	0,1	0
10c. Airplane: # seconds	1.98	.21	1.36	.58	2	2	1,2	0,1
11a. Scooter board: head position	.89	.31	.45	.51	1	0,1	0,1	0
11b. Scooter board: shoulders	.75	.44	.36	.49	1	0,1	0,1	0
11c. Scooter board: hips	.51	.5	.05	.21	1	0	0	0
11d. Scooter board: extraneous movements	.87	.33	.27	.46	1	0,1	0,1	0
11e. Scooter board: bilateral steps	2.85	.41	1.73	.94	3	2	2	0,1
12. Scooter board: alternate steps	2.56	.7	1.05	1.0	3	2	2	0,1
3a. ATNR-right: head resistance	1.63	.51	.77	.69	2	1	1	0
13b. ATNR-right: elbow flexion	1.25	.48	.77	.75	1,2	1	1	0
13c. ATNR-left: head resistance	1.64	.5	.77	.69	2	1	1	0
13d. ATNR-left: elbow flexion	1.33	.49	.77	.75	1,2	1	1	0
14a. STNR: head flexion	1.57	.5	1.23	.75	2	1	1,2	0
14b. STNR: head extension	.93	.26	.45	.6	1	1	1	0
15. Quadruped: bat ball	.89	.31	.27	.46	1	0,1	0,1	0
16. Tug of war:	1.54	.5	1.0	.44	2	1	1	0,1
17a. Visual track: horizontal	1.76	.54	.82	.80	2	1	1,2	0
17b. Visual track: vertical	.95	.22	.27	.46	1	1	0,1	0
18a. Open-close: repetitions	2.93	.39	2.14	.83	3	2,3	2,3	0,1
18b. Open-close symmetry	.83	.38	.23	.43	1	0,1	0,1	0

INDIVIDUAL ITEM ANALYSIS

Item	NORMAL CHILDREN		DELAYED CHILDREN		SCORE INTERPRETATION			
	Mean	SD	Mean	SD	Upper Range of Normal	Lower Range of Normal	Slightly to significantly Delayed	Severely Delayed
19a. Drumming: repetitions	2.85	.56	1.91	.87	3	2	2,3	0,1
19b. Drumming: symmetry	.81	.39	.18	.39	1	0,1	0,1	0
20a. Schilder: head resistance	.84	.62	.23	.53	1,2	0,1	0,1	0
20b. Schilder: steady arms	1.03	.76	.27	.63	1,2	0,1	0,1	0
20c. Schilder: trunk rotation	.36	.48	.05	.21	1	0	0	0

TABLE 9
INDEX ANALYSIS

Index	NORMAL CHILDREN		DELAYED CHILDREN		SCORE INTERPRETATION			
	Mean	SD	Mean	SD	Upper Range of Normal	Lower Range of Normal	Slightly to significantly Delayed	Severely Delayed
I. Postural Control								
A. Flexion (includes items 1a,1c,3,4a,4b)	9.07	1.205	4.7	2.374	11	8 to 10	2 to 7	0 to 1
B. Extension (includes items 5a,7b,7c,7d,8a, 8b,9a,9b,9c,9d, 10a,10c,11a,11b, 11c,11d)	23.253	3.118	11.591	5.466	24 to 26	18 to 23	6 to 17	0 to 5
C. TLR integration (includes all flexion and extension items)	32.474	4.307	16.	8.367	34 to 37	26 to 33	8 to 25	0 to 7
D. Co-contraction (includes items 6a,6b,6c,16)	5.147	1.101	2.682	1.585	6	4 to 5	2 to 3	0 to 1
II. Reflex Integration (includes items 13a,13b,13c,13d, 14a,14b,15,20a, 20b,20c)	11.474	2.333	5.591	3.660	14 to 17	9 to 13	2 to 8	0 to 1
IV. Bilateral Motor Integration (includes items 1b,5b,7a,10b, 11e,12,18a,18b, 19a,19b	16.379	1.863	9.364	4.054	16 to 18	14 to 15	5 to 13	0 to 4

Test Score Interpretation

Analysis of discriminating power for each test item found that some items are better indicators of sensori-motor integration function than others. Items that clearly identify children with severe deficits from all others are more primal in nature. These include basic stability when prone on elbows; extension of the head in prone postures; maintenance of the quadraped position when the tonic neck reflexes are elicited; visual tracking in a vertical plane; symmetrical grasp patterns; and crossing the midline or transferring to a preferred hand. The items in this category are represented in Column A of Table 10.

Other items that are considered significant indicators of sensori-motor integration function are those that delineate a definite progression from the upper and lower ranges of normal, slight to significantly delayed to severely delayed. These are identified in Column B of Table 10. This progression is observed in muscle tone; co-contraction; maintenance of anti-gravity postures of flexion and extension; bilateral symmetrical and alternating stepping movements while in prone extension postures; and resistance of the head when the asymmetrical tonic neck reflex is elicited in the quadraped position.

Some test items clearly discriminate between the performance of children in the upper normal and severely delayed ranges but show overlap in the performance of children in the low normal and significantly delayed ranges. Findings from these test items are useful in supporting data of the stronger indicators described above but cannot be used exclusively by themselves for decision making due to the probability of error. Items in this category are listed in Column C of Table 10. They include items that observe rotation, extraneous movements, and symmetry during extension postures; head and shoulder positions on the scooter board while prone; examination of the symmetrical tonic neck reflex in the quadraped, bat ball activity; visual tracking in the horizontal plane; symmetry of hand movements during drumming and open-close patterns; and head resistance and steadiness of the arms in the Schilder arm extension test.

A small percent of test items fell in the category which discriminate only those children in the upper range of normal. Since the assessment was designed for developmentally delayed children, these items have the least significance since a substantial number of normal children in the low range have not acquired the skill either. These items include rotation in a body flexion activity; hip position in extension tasks; elbow extension while weight bearing on the arms; and trunk rotation in the Schilder arm extension test. Items in this category are listed in Column D of Table 10.

TABLE 10
TEST SCORE INTERPRETATION

A	B	C	D
Items clearly discriminating severe delay only.	Items demonstrating clear progression from upper range of normal to severely delayed.	Items clearly differentiating upper range of normal and severely delayed: overlap of low range normal and significant delay.	Items differentiating upper range of normal only.
1a. #Sit-ups 1b. Sit-ups: hand use 5a. Prone on elbows: position 6a. Co-contraction: head position 7a. Rolling pin: grasp 7d. Rolling pin: head position 9a. Wheelbarrow: head position 10c. Airplane: # seconds 13b.&d. ATNR: elbow flexion 14a. STNR: head flexion 14b. STNR: head extension 17b. Visual track: vertical	2. Muscle tone 3. Neck flexion 4a. Monkey: position 4b. Monkey: # seconds 6c. Co-contraction: # seconds 7b. Rolling pin: # lifts 8b. Belly crawl: # steps 9d. Wheelbarrow: # steps 10a. Airplane: support 11e. Scooter board: bilateral steps 12. Scooter board: alternate steps 13a.&c. ATNR: head resistance 16. Tug of war	5b. Prone on elbows: hand use 6b. Co-contraction: resistance 8a. Belly crawl: rotation 9c. Wheelbarrow: extraneous movements 10b. Airplane: symmetry 11a. Scooter board: head position 11b. Scooter board: shoulders 11d. Scooter board: extraneous movements 15. Quadruped: bat ball 17a. Visual track: horizontal 18b. Open-close: symmetry 19b. Drumming: symmetry 20a. Schilder: head resistance 20b. Schilder: steady arms	1c. Sit-ups: rotation 7c. Rolling pin: hip position 9b. Wheelbarrow: elbow position 11c. Scooter board: hip position 20c. Schilder: trunk rotation

APPENDIX A

REVIEW OF LITERATURE

REVIEW OF THE LITERATURE:

Postural Control: The first gross motor skills to develop in normal children are those that involve the head and trunk. The neck and trunk muscles give the child stability as he moves, and their development lays the basis for postural control. If these muscles are not well developed, the child is often unstable while maintaining body postures and may have poor fine manipulative and locomotor skills. When the nerve tracts that innervate the proximal muscles of the trunk and shoulder girdle are severed in monkeys leaving nerve tracts innervating the distal arm and hand muscles intact, refined hand movements cannot be performed (Laurence and Kuypers, 1968). Thus, the proximal muscles of the trunk are necessary for refined arm and hand movement.

There is currently very little information in the literature regarding the development of postural control in preschool children. One study (Shambes, 1976) compared the postural control exhibited by four year old children with that demonstrated by eight year olds. The subjects were evaluated while they were maintaining static postures, for example lying prone on their elbows. Electromyography, center of gravity, and photographic procedures were used to collect data. Shambe concluded that the eight year old group tended to use fewer muscles with smaller amplitudes in muscular activity while holding a static position, and that the older children also had a higher degree of muscle localization with fewer extraneous body movements compared to the four year old group.

Proximal control is necessary for the execution of skilled hand movements. A study of the maturation of fine prehension skills using pre-school age children as subjects found that the refinement of fine manipulative and locomotor skills occurs at about six years of age (Rosenbloom & Horton, 1971). This finding is substantiated by developmental scales that correlate the maturation of postural reactions with the development of balance.

The nerve centers which assist the child in maintaining different body postures are located in the brain stem. Their purpose is to coordinate the entire body musculature as it assumes and maintains postural stances. These nerve centers are connected to the labyrinths which react to changes in posture; the proprioceptors of the muscles, joints, and tendons which respond to pressure, position, or stretch; and the sensory receptors, including vision and touch, which provide information about body orientation and the distances of the joints from each other (Magnus, 1925).

Stockmeyer (1967) has identified a progression in which postural control develops that is closely related to the development of gross motor skills. The flexor feeding pattern is the first major motor pattern to develop in the infant. It is a pattern of total body flexion and is closely associated with feeding and eye-hand coordination at the body midline. This position also facilitates convergence of the eyes at close range and grip in the hands.

The pivot prone position is the first postural pattern to develop of which all later postural patterns depend. In this position, the child develops extensor tone in the neck and trunk muscles which is necessary for weight bearing on the arms and bilateral development of scapular musculature. If the pivot prone position is not well developed, the child will show a lack of precision when reaching for objects and will be very unstable in holding body postures.

After the pivot prone position is well established, the child develops co-contraction of the neck. This is when both the neck flexors and extensors are able to contract simultaneously in a coordinated manner. Until now, the child has been able to contract either the flexors or the extensors by themselves but not simultaneously. When co-contraction of the neck develops, the neck will be able to move steadily in a controlled manner towards either side. Co-contraction of the neck is especially important for the development of visual perception as neck stability is needed before the eyes can become stabilized. The development of the neck muscles is also crucial for feeding and speech development. Co-contraction of the arms develops after co-contraction of the neck has been established. If a child lacks co-contraction, he will show excessive movements when attempting to hold a posture.

The next stage in postural development is indicated by a position called prone-on-elbows. In this position, weight is placed on the elbows which helps to develop shoulder muscle strength. When the baby has developed the ability to maintain the prone-on-elbows position he is able to shift his weight from shoulder to shoulder. This weight shift is important for learning to rotate the trunk. When shoulder control is gained, the child will be able to reach with one arm for an object while the other elbow bears his weight. At first, the object must be near the body midline; later the child will be stable enough for extended reaching. The prone-on-elbows position helps to improve the simultaneous use of both hands in an activity.

The last stage of prone development is the prone extension posture. In this position the child fully extends both arms while supporting his body weight. It is preparatory for both the hand-and-knees position and for crawling. An inability to assume this position may be caused by overactivity of the flexors, weakness in the upper extremities, and/or lack of precision in reaching.

Reflex Integration:

Reflexes appear and disappear at different times in the maturation of the central nervous system and, for this reason, they are good indicators of the development of the central nervous system. If there is a lesion in the spinal cord or in some portions of the brain, the control from the cortex may be disrupted and the primitive reflexes may not be inhibited as they should be. As a result, the child may demonstrate abnormal postures, movements, and muscle tone.

At birth, the baby's movements are dominated by primitive reflexes that are controlled and mediated by the spinal cord and brain stem. The baby responds mechanically and automatically to changes in the position of his head and body and is unable to move against gravity. These primitive reflexes gradually lose their influence as higher brain centers develop and suppress them, allowing for more conscious and voluntary movement. The degree that the primitive reflexes remain active depends on the maturation and integration of the higher postural reflexes that make it possible for the child to maintain balance in different body positions. Developmentally delayed children often demonstrate many of these primitive reflexes but to a mild degree. Their presence prevents them from developing adequate eye-hand coordination and postural control.

In the young infant, motor behavior is influenced by the asymmetrical tonic neck reflex (ATNR) which affects the baby's muscle tone in his arms and legs according to the position of the head while in a back-lying position. It is elicited by stimulation of the receptors in the joints of the neck (Ayres, 1972). The arm and leg on the skull side are held in flexion while the arm and leg on the face side are held in extension. The effect on the lower extremities is less pronounced than is the effect on the arms. The ATNR aids in initial reaching for objects as the baby visually fixates on his extended arm. It also aids in assuming a suitable posture for breast feeding (Gesell, 1954). If the reflex remains strong, it interferes with the development of eye-hand coordination. It is very important to note that this response normally occurs only occasionally rather than each time the baby moves. When the ATNR occurs after six months of age, it is an indicator of cerebral dysfunction. Until the ATNR is integrated, the child often has difficulty with midline activities and tasks requiring rotation of the neck and trunk musculature.

Another postural reflex affecting the child's sensori-motor integration is the tonic labyrinthine reflex (TLR). It is named after the labyrinths which respond to gravity changes and which supply information as to the body 's orientation in space, particularly the position of the head. When supine-lying, a predominance of extensor tone exists and while prone-lying, flexor tone persists. The TLR begins to lose its influence during the first three months of life, permitting the infant to lift his head and arms against gravity. The TLR's influence must be reduced for the development of voluntary head and trunk movements and before the child can assume the flexor feeding and pivot prone postures.

Another reflex that is often demonstrated by children with cerebral dysfunction is the symmetrical tonic neck reflex (STNR). It occurs at six to eight months of age and assists the child in getting on his hands and knees. The STNR is elicited when the head is tilted downward, the arms flex and the legs extend so that the body collapses from hands and knees. It can also be elicited by extending the neck which causes extension of the upper extremities and flexion of the lower extremities. If this reflex is poorly integrated, the child will "bunny-hop" when he crawls, keeping his flexed hips close to the ground. Thus the child often lacks adequate trunk control and his stomach sags when he is on his hands and knees.

Ayres (1972) has studied learning disabilities extensively and has observed that the presence of the primitive reflexes, and particularly the ATNR and TLR, in conjunction with other signs, are associated with poor sensory integration in the brain. She has found that

> ... the TNR and TLR are present in all individuals at all times, but age and the degree and type of CNS (central nervous system) integration determines the ease with which they are elicited or the degree to which they dominate the CNS. It is the degree to which these reflexes have been integrated in the nervous system, not whether they are present. (p. 106)

There have been few studies of primitive reflexes in normal individuals. It has been found, however, that stressful activities can elicit the ATNR in the normal adult. For instance, it has been observed in the arm swing when playing golf. Studies by Hellebrandt (1956) and Fukuda (1961) using normal adults found that the ATNR can be elicited by tasks involving a heavy resistance. The exercising limb reflexively influences the other extremity. In similar fashion, the head posture is altered in a heavy work task that involves the arms which in turn increases the performance output of the individual. Both the ATNR and TLR may manifest themselves in changes in the distribution of muscle tone rather than observable position changes of the extremities.

Electromyographic studies of the tonic neck and tonic labyrinthine reflexes in normal adults found that postural changes were not observed in the upper and lower extremities, however, discharge of neuromuscular units were detected. Proximal muscles were effected moreso than distal ones under the influence of the tonic neck reflex. Likewise, higher EMG activity was found in distal muscle groups over proximal muscles in postures eliciting the tonic labyrinthine reflex (Tokizane et al, 1951-52).

Parmenter (1975) measured the ATNR in normal first and third graders while they assumed a hands-and-knees position. With head turning to one side, the six year olds demonstrated significantly more evidence of the reflex, especially to the left side. Visible changes in muscle tone with flexion of the skull side arm up to 30 degrees was found to be normal up through eight years of age.

Bilateral Motor Integration:

Bilateral motor coordination refers to the ability to differentiate the two sides, right from left, and to use the two body sides together in coordinated activity. Bilateral motor integration develops as a result of communication between the two brain hemispheres which allows the brain to function as a whole rather than as two separate halves. As this communication develops, the two hemispheres take on the specialized functions necessary for hand and eye dominance. Integration of the two brain halves is essential for the two sides of the body to coordinate, for integration of mental processes, and for coordination of the two halves of the visual field (Ayres, 1972).

The cerebral commissures are joined together by the corpus callosum which integrates sensory information between the two hemispheres by allowing convergence of functions of each hemisphere. The corpus callosum transfers information from the specialized hemisphere to the non-dominant hemisphere, however, each hemisphere does not rigidly specialize as one hemisphere can compensate for functions of the other hemisphere if a lesion occurs early in life (Semmes, 1968). In studies of split-brain humans, some specific deficits have been noted. One study found that one hand may be unaware of what the other is doing; for instance, one hand may be tying the shoelaces while the other unties them. Or the person may be able to name an object held in the right hand, but not one held in the left hand. This occurs because the ability to name objects is a function of the left hemisphere (Noback and Demarest, 1972). In a study with split-brain monkeys, Hamilton (1967) found that his subjects did not transfer an object from one hand to the other.

At birth, the infant is dominated by asymmetries in his movements. The baby normally assumes the asymmetrical tonic neck reflex and frequently reaches with one hand, usually the one that is extended in the ATNR. The use of one hand over the other fluctuates a great deal in the first ten months of life. The baby may also be forced to use one hand in reaching for and grasping an object because he has not developed the motor control and balance necessary for the use of both hands. For instance, when the baby first learns to sit up, he is forced to use only one hand in manipulating an object as the other is needed to stabilize and maintain his balance. Basic patterns of reach, grasp, release, and control of individual fingers are established in each hand before bilateral hand skills or the specialization of one hand can occur (Gesell, 1977).

The ability to use two hands together emerges at eight months of age. This first develops in movements that are symmetrical and which use the sides of the body in unison. Some activities that illustrate this are pat-a-cake which emerges at about nine months of age, and throwing a ball with two hands, jumping with two feet together, and pulling apart pop beads, all of which are skills that develop at one and one-half to two years of age.

To further differentiate the two body sides from each other, the child begins movements that contrast the two body sides in reciprocal movements. It is first seen in reciprocal crawling at 9 months of age. Some other activities with opposing movements are unscrewing a jar lid, stringing beads, cutting with scissors, and riding a tricycle, all of which develop around age three.

Another aspect of the development of bilateral motor coordination is the ability to transfer an object from one hand to the other which first develops at about five months of age. As individual hand skills become more refined, and as the bilateral use of hands develop , the child progresses towards finer, more precise movements. As early as 18 months to two years of age, hand preference begins to emerge. The dominant hand develops greater manipulation skill while the other hand assumes an assistive role.

Many children are born with a predisposition for handedness; however, which hand actually develops as dominant depends largely on the developmental process. Hand dominance should be well established by five to six years of age. In those children who interchange hands, a critical break is seen by nine years of age towards developing a dominant hand. Some studies show that right-handed children tend to have better dexterity in grasp and reach than left-handed children. Ambidexterous children often demonstrate irregular development, especially in language, since neither cerebral hemisphere has specialized functions. When hand dominance appears, many of these problems disappear (Ayres, 1972).

The most obvious symptom of a child who has not developed bilateral motor integration is that he has not developed strong hand preference. Each hand seems to act independently of the other, and whichever hand is closest to the object is used. The child does not bring the hands together to manipulate the object. Motor actions of the two hands tend to be uncoordinated and jerky. The child may avoid crossing one hand over to the opposite side of his body to reach for a toy. The body's midline is significant in body scheme disorders. The child may also avoid crossing the midline by rotating the entire body.

Children with poor bilateral motor integration have difficulty with tasks that require bilateral movements. These may be difficulties with symmetrical tasks such as jumping or clapping or alternating hands in a tug-of-war or drumming. The child may also lack symmetry and control in gross motor movements. As a result, the child is often very clumsy and stiff in gross motor tasks such as rolling and walking as these require the two sides of the body to coordinate on a gross level. The child lacks flexibility in rotating the trunk from side to side as the lateral trunk muscles are not well developed.

Children with bilateral motor integration problems most frequently have poor postural control as well. The precise neurological mechanism which links these two together is not understood. It seems that development of the trunk musculature is a bilateral activity and is primal to development of the two hands in bilateral tasks (Ayres, 1972).

Another problem seen in children with poor bilateral integration is difficulty in crossing the body midline with the eyes. The child may look away when his eyes come to the midline point and then have difficulty finding the target again. Vertical tracking is especially difficult for these children. As a result, visual form and spatial perception deficits are often seen.

Vestibular Function:

The vestibular system consists of the labyrinths in the inner ear and the vestibular nuclei in the brain stem which detect changes in the position of the head in space. The structures in the labyrinths include the semicircular canals which respond to rotatory movement and the utricle and saccule which respond to linear movement and gravity. The vestibular system communicates positional changes to the ocular muscles and to other parts of the brain controlling movement, particularly the cerebellum, through nerve pathways (Jongkees, 1975). Descending impulses from the vestibulospinal tracts affect extensor muscle tone which enables the body to lift against gravity and maintain an upright posture. In this way, the vestibular system regulates body posture, muscle tonus, ocular-motor control, and equilibrium.

Several studies have documented the influence of the vestibular system on extensor tone and body posture. During stimulation of the horizontal semi-circular canals, an increase in EMG activity was found in the upper extremity extensors (Anderson et al, 1977). Ottenbacher (1978) compared the supine flexion and prone extension postures and found a significant relationship to each other, however, there was a high correlation between vestibular function and the prone extension posture only.

There is a very close connection between the semi-circular canals and head posture. When the vestibular nerve was stimulated electrically in cats and pigeons, a reciprocal excitatory and inhibitory innervation occurs in the neck motoneurons. This is necessary for precise control of neck movements (Wilson and Maeda, 1974). In studying 27 genera of mammals, particularly bats, Mohl (1977) found that the animals when alert held their heads in a position so that the horizontal semi-circular canals were constantly stimulated. In man, the semi-circular canals are horizontal when the neck is flexed at 30 degrees. In a study of twenty-two deaf children from early infancy to ten years of age who had hypoactive nystagmus, ten of the children were found to be delayed in motor development. However, of those who walked at a normal age, some were described as having "'weak necks' or 'floppy heads'." (Rapin, 1974) This study points out the importance of studying postural control and neck reflexes.

In addition to the development of reflexes and body posture, the vestibular system affects the development of visual-spatial perception in its effect on the ocular muscles. It helps the eyes to perceive whether an object is moving, whether the eyes or the head is moving, and the relationship between the body's movement and its position in space. In a study with infants, vestibular-proprioceptive stimulation provided in a horizontal or semi-vertical posture significantly enhanced visual pursuits whereas a stationary upright position did not (Gregg et al, 1976). Another study examined eye movements in rabbits when rotated in different body orientations. The eyes made distinct movements in the same clockwise direction as the body movement. Gresty (1976) concludes that eye movements stimulated by neck reflexes may be more related to body orientation and maximum use of the visual field than eye stabilization or visual pursuit alone. Schizophrenic children with vestibular dysfunction demonstrated by minimal or absent post-rotary nystagmus had very poor oculomotor control (Pollack and Krieger, 1955).

Because of the vestibular system's location in the inner ear, it is hypothesized that adequate vestibular function is necessary for perception of sound and understanding of language. It is also thought that the vestibular system may contribute to communication between the two brain hemispheres, as it is located at the junction of the two brain halves where neural tracts from all parts of the brain converge for processing. Consequently coordination of the two body sides is also affected. Ayres believes that stimulation of the vestibular system will facilitate convergence of the neural tracts in the thalamus and improve the speed and efficiency of synaptic transmission (Ayres, 1972).

Recent research has found that disorders in the vestibular system can produce learning disabilities associated with motor skills and acquisition of language (De Quiros, 1976). Ayres found that 50% of identified learning-disabled children demonstrated inadequate vestibular functioning. Steinberg and Rendle-Short (1977) report that children with minor neurological dysfunction had a high proportion of deficits in postural reactions, particularly in the prone position, vestibular function and visual-spatial skills. Additional research has confirmed the role of vestibular function in the acquisition of motor skills. When the vestibular nerve was sectioned in cats, cortically controlled movement in an extremity was diminished significantly when the brain stem was stimulated (Kempinsky and Ward, 1950). Although most of the research has focused on learning-disabled children, one study provided vestibular stimulation to normal and developmentally delayed infants for ten days and found significant improvement in reflex and motor development in those infants with delays in these areas (Kantner, et al, 1976). Similar results were found in a study of 26 normal pre-ambulatory infants when exposed to mild semi-circular canal stimulation for four weeks (Clark et al, 1977).

Review of Available Tests:

There are a number of reflex tests and scales of fine and gross motor development available to the occupational and physical therapist for use in assessing the child's level of functioning in the motor area. Some of the fine and gross motor assessments frequently used for preschoolers include the Denver Developmental Screening Test (Frankenburg & Dodds, 1966), the Koontz Child Development Program (Koontz, 1974), and the Children's Hospital at Stanford Functional Developmental Assessment prepared by Claudia Brower, OTR (Bleck & Nagel, 1975). These tests have been developed for use at different age levels for particular abilities and they demonstrate a lack of consistency from test to test. Most of them are also based on a limited normative sample and limited normative data. None of the scales provide qualitative measures for assessing movement patterns. For example, in a task such as scissor cutting, a normal three year old may demonstrate mirroring movements of the hand that he uses to hold the paper while an older child can hold the paper steady. The therapist must often rely upon clinical judgment to determine if the child is within normal limits. In addition, there are very few test items on the fine and gross motor tests that provide information about the child's postural control, reflex integration, and bilateral motor integration. It is possible to test the child's bilateral assistive skills using the fine motor scales in tasks such as unscrewing a jar lid and buttoning. These, however, do not test other functions of bilateral motor integration such as crossing the body midline or symmetry of arm movements.

Ayres (1972) has standardized a battery of perceptual-motor tests called the Southern California Sensory Integration Tests (SCSIT) that has norms for children four years and older. Bilateral motor coordination is assessed in a series of items that require the child to imitate simple drumming and clapping rhythms with the hands. According to the norms, a four year old cannot be expected to perform any of the items and a five year old need only complete one item to be considered within the normal range. The test requires good imitation skills and an understanding of basic number concepts. Another subtest that has norms beginning at age four examines the child's ability to cross the body midline. The subtest is based on the child's imitative skills and the child is scored according to whether he touches his eye or ear with the same or opposite hand in imitation of the examiner. The scale does not, however, assess the crossing midline function in manipulative tasks. Accuracy of aim and emergence of hand dominance are both tested in a motor accuracy subtest. The child is asked to draw on the heavy black line of a large butterfly shaped design. This test provides some indication that the child may have instability of the proximal muscles although it does not identify the components of the problem if it is found to exist. It is, however, an excellent indicator of the degree of hand specialization.

Ayres has developed a set of clinical observations which examines muscle tone, postural control, and reflex integration which is administered in conjunction with the SCSIT. No criteria is available for scoring other than an arbitrary range from a normal response to definite dysfunction leaving differentation of responses up to the therapist's clinical judgment. The observations are not standardized. Despite the availability of this test, the items assessing supine flexion, prone extension, co-contraction, and the ATNR inhibiting posture are too difficult for a three to five year old as they are unable to understand the concept of "holding" a complex body position.

The Southern California Postrotary Nystagmus Test (Ayres, 1975) is available for assessment of vestibular function. It is standardized for children five through nine years of age. It involves seating the child in a cross-legged position on a rotation board which spins freely in either direction. The child's head is flexed 30 degrees, then rotated in one direction at a rate of 10 times in 20 seconds, then abruptly stopped. Nystagmus, an involuntary horizontal movement of the eyes, is measured using a stopwatch while the child looks at a wall to avoid focusing the eyes. Observations include excursion of eyeballs, balance reactions, and autonomic responses such as dizziness and nausea. The child is tested in both directions. As there are no norms for three and four year olds, data collection is needed to identify the vestibular function of this age group.

The reflex tests that are commonly used are Reflex Testing Methods for Evaluating C.N.S. Development (Fiorentino, 1973), Developmental Assessment: A Test for Gross Motor and Reflex Development (Hoskins & Squires, 1973), and Routine Developmental Examination in Normal and Retarded Children (Milani-Comparetti & Gidoni, 1967). Each of these tests assesses the primitive reflexes and the righting reactions through the maturation of equilibrium reactions in positions that are the least stressful to the child. From the research cited earlier, it has been found that the primitive reflexes, particularly the tonic neck and tonic labyrinthine reflexes, exist throughout life in normal individuals to varying degrees, and that they can be elicited under stressful body positions. Children with developmental delays and deficits in sensori-motor integration demonstrate subtle signs of these abnormal reflexes more so than normal children. Using the present reflex tests, a child with poor reflex integration may not be identified. Because of their effects on eye-hand coordination, and on the development of fine motor and perceptual-motor skills, it is important that the presence of these primitive reflexes be tested.

Using the tests presently available, a child with poor postural control, poorly integrated reflexes, poor bilateral motor integration, and/or vestibular dysfunction may not be identified as having specific problems in these areas. Most likely treatment will be aimed at improving their fine and gross motor abilities when treatment should be directed towards a more basic level of intervention. The development of refined fine and gross motor skills depends on good postural stability, integrated reflexes, and the well developed use of the two body sides. None of these are adequately assessed by any of the presently available measures, singly or in combination.

APPENDIX B

PARENTS' QUESTIONNAIRE

Dear Parent:

I would appreciate if you could fill out the following information for me. It will be used to determine if you have any concerns about your child's motor development and to get a general idea about the level your child is functioning at in motor skills. Please add any other comments you may have.

Name of Child: ______________________________

Date of Birth: ______________________________

1. Are you concerned about your child's gross and fine motor development? If so, what are your concerns? Yes _____ No _____

2. Is your child clumsy, awkward, or uncoordinated when performing various tasks? Yes _____ No _____

3. Have you ever consulted a pediatrician or a motor specialist (such as a physical therapist) about any motor problems your child might have? Yes _____ No _____ Does not apply _____

4. Please check off which skills your child is able to do. The skills given below range from three through six years of age. If you do not know if your child is able to do the task, please mark it with a question mark.

_____ Pedals a tricycle
_____ Jumps with both feet together
_____ Strings large beads
_____ Holds a pencil in a mature, adult manner
_____ Cuts with scissors on a line
_____ Hops on one foot
_____ Walks up and downstairs alternating feet without holding on a rail.
_____ Buttons small buttons
_____ Laces shoes
_____ Screws a jar lid on
_____ Skips alternating feet
_____ Shows a definite hand preference
_____ Dresses himself independently

Thank you very much for your cooperating in this study.

Georgia DeGangi OTR
Georgia DeGangi, O.T.R.

APPENDIX C

THE ASSESSMENT OF SENSORIMOTOR INTEGRATION IN PRE-SCHOOL CHILDREN

This test is an assessment of postural control, reflex integration, bilateral motor integration, and vestibular function. It is designed as a criterion referenced test for the developmentally delayed child with sensori-motor integration dysfunction. The test, consisting of 21 items, is administered individually and takes approximately one-half hour. Before administering the test, the therapist should become familiar with the test procedures and scoring criteria. Equipment needed should be set up prior to testing. A list of equipment and space required are described in the Test Administration section. Verbal directions should be given as they are specified in each test item. The child may be urged to continue repetitions until fatigued.

Scores are recorded on the Protocol Sheet as the test is administered. Score interpretation is described in detail in the Data Analysis and Test Score Interpretation sections. Tables 8 and 9 are used to determine the child's level of functioning. Score Sheet I is used with those children who are able to complete the entire test when compiling the scores. For those children who are able to complete only parts of the test, Score Sheet II is used.

Data is available for all test items except #21, post-rotary nystagmus, as this item requires much practice in administering and scoring before good reliability can be attained. It is included on the test however, to provide procedures for the younger child and questions to elicit emotional-physiological responses. For those therapists experienced in administering the post-rotary nystagmus test, it should be examined in relation to the other vestibular based functions on the assessment.

1. **SIT-UP**:

This test item asseses strength of the trunk flexors and hand preference.

Equipment Needed: 10 Standard size bean bags and one large coffee can

Procedure:

Instruct the child to lie on his back on the mat. Flex the child's knees and place a large-sized coffee can between his feet. Place 5 bean bags one foot to the right of one shoulder and 5 bean bags to the left of the other shoulder. The task involves picking up one bean bag at a time, sitting up and placing it in the can, then lying back down again. Instruct the child, "PICK THE BEAN BAGS UP ONE AT A TIME AND PLACE THEM IN THE CAN." Reminders may be given to pick up only one bean bag at a time and to lie back down completely between each repetition. The examiner holds the child's feet so that the knees remain flexed. Count the number of repetitions. Observe the amount of trunk rotation during the sit-ups and each hand for crossing the midline and/or transferring of the bean bag to a preferred hand.

Scoring:

a. Number of sit-ups:
_____ (0 repetitions = 0 pt.)
_____ (1 to 5 repetitions = 1 pt.)
_____ (6 to 10 repetitions = 2 pt.)

b. Hand use during task:
_____ (uses hand closest to bean bag only = 0 pt.)
_____ (crosses midline or transfers bean bag to preferred hand = 1 pt.)

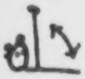
c. Amount of trunk rotation
_____ (complete or partial rotation to side = o pt.)
_____ (no rotation to side = 1 pt.)

2. MUSCLE TONE:

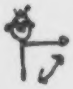
Procedure:

While the child is lying on his back, gently shake one of the arms to relax it. Tell the child, "I'M GOING TO MOVE YOUR ARMS IN DIFFERENT WAYS. SEE HOW RELAXED YOU CAN BE. LET ME DO ALL THE WORK." If the child remains tense or actively moves his arm, gently shake the arm and repeat the directions if needed. Distract the child's attention from the ranging by engaging the child in conversation or placing a music box or toy on his stomach to watch.

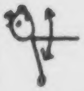
In each of the following positions note the amount of muscle tension. It is important to move the arm in a quick, continuous motion. Test for both arms.



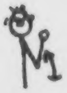
a. Shoulder flexors and extensors: Lift the arm into full shoulder flexion. Quickly move the arm down to the child's side to 0° shoulder flexion, then up again into full shoulder flexion for 3 repetitions.



b. Shoulder abductors and adductors: Move the arm out into full shoulder abduction, then quickly move the arm back to a position of 0° abduction and up again into full abduction for 3 repetitions.



c. Shoulder horizontal abductors and adductors: Begin with the arm at a position of 90° shoulder abduction. Move the arm quickly across the chest to full horizontal adduction, then back again to full horizontal abduction for 3 repetitions.



d. Elbow flexors and extensors: Fully flex the elbow. Quickly move the arm into full extension, then return to full flexion for 3 repetitions.

Scoring:

Summarize the findings of the quick ranging by scoring the muscle tone in one of the categories below.

Hypertonia is defined as marked muscle tension with moderate to severe resistance to quick stretch and passive movement.

Normal muscle tone is defined as a slight increase in muscle tension with slight resistance to quick stretch and passive movement.

Hypotonia is defined as diminished muscle tension with no resistance to quick stretch and passive movement.

	RIGHT	LEFT	
a. Moderate to severe hypotonia:			(0 pt.)
b. Slight hypotonia:			(1 pt.)
c. Normal tone:			(2 pt.)
d. Slight hypertonia:			(3 pt.)
e. Moderate to severe hypotonia:			(4 pt.)

3. NECK FLEXION:

This test item assesses strength of the neck flexors.

Equipment Needed: One red yarn ball suspended on a string.

Procedure:

The child remains on his back. Hold a suspended yarn ball 4 inches above the child's forehead. Instruct the child, "SEE MY YARN BALL? TRY TO HIT IT WITH YOUR FOREHEAD." (Touch child's forehead lightly.) "SEE HOW MANY TIMES YOU CAN DO IT." Do not allow the child to prop on his elbows during the task.

Count the number of times the child flexes his neck to hit the ball. If the child props on his elbows or attempts to flex his upper trunk by lifting his shoulders off the mat, the attempt is not counted.

Scoring:

Number of repetitions

_____ (0 repetitions = 0 pt.)
_____ (1 to 5 repetitions = 1 pt.)
_____ (6 to 10 repetitions = 2 pt.)
_____ (11+ repetitions = 3 pt.)

4. MONKEY:

This test item assesses integration of the tonic labyrinthine reflex in supine and the strength of the body flexors.

Equipment Needed: One dowel (3 feet long x 3/4 inch diameter)

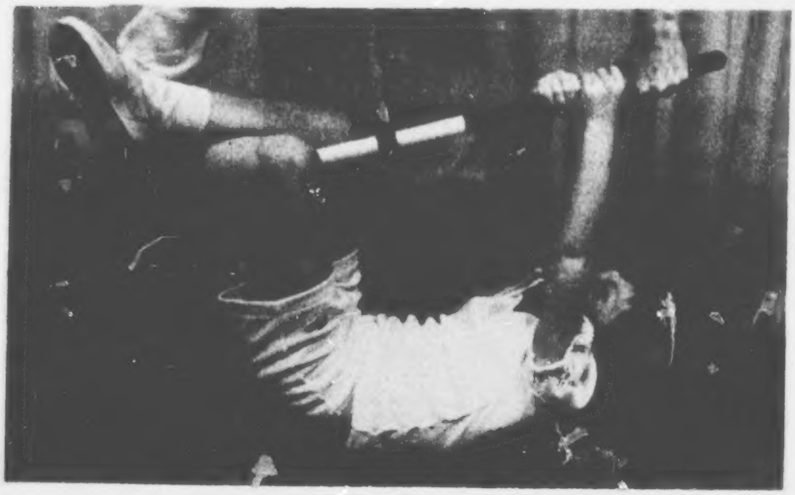
Procedure:

While the child is lying on his back, hold a long dowel lengthwise along the child's body midline. Instruct the child, "WE'RE GOING TO PLAY A GAME CALLED MONKEY. YOU'RE THE MONKEY AND THIS IS MY BRANCH. HOLD ONTO THE POLE WITH YOUR HANDS." Assist the child in grasping the dowel. "NOW CROSS YOUR LEGS LIKE THIS OVER THE POLE." Cross the child's legs at the knees over the dowel. "HOLD ON TIGHT. I AM GOING TO LIFT YOU UP IN THE AIR. KEEP YOUR NOSE CLOSE TO THE POLE. SEE HOW LONG YOU CAN DO IT." Hold the dowel at each end and lift the child one foot above the mat. Begin the stopwatch as soon as the child leaves the ground and continue timing until the chil lowers his body position or releases his grasp. Reminders may be given to "KEEP YOUR NOSE TO THE POLE" initially if the child needs urging or assumes a posture with his arms and neck extended. Record the child's body position and number of seconds held.

Scoring:

a. Ability to hold position:
_____ (unable to hold = o pt.)
_____ (assumes but loses grip when lifted = 1 pt.)
_____ (Head lower than 6" below dowel, arms flexed 0 to 45° = 2 pt.
_____ (head within 3 to 6" below dowel, arms flexed greater than 60° = 3 pt.)

b. Number of seconds held:
_____ (0 seconds = 0 pt.)
_____ (1 to 5 seconds = 1 pt.)
_____ (6+ seconds = 2 pt.)



5. PRONE ON ELBOWS, PEGBOARD:

This test item assesses stability of the trunk and shoulders when prone on elbows and hand use in this position.

Equipment Needed: One pegboard and ten 1/2 inch pegs.

Procedure:

Instruct the child to lie on his stomach on the mat, propped on elbows. Place the pegboard in front of the child, centered at the midline. Lay five pegs in a horizontal row spaced 2" apart on one side of the pegboard and another five pegs similarly spaced on the other side. Instruct the child, "PUT ALL THE PEGS IN THE BOARD." Observe the child's body position and each hand for crossing the midline and/or transferring of pegs to a preferred hand. If the child rotates to a side-lying position anytime during the task even though he may re-assume a prone on elbows position, a score of 0 is assigned.

Scoring:

a. Body position during task: _____ (rotates to side-lying = 0 pt.)
_____ (maintains position = 1 pt.)

b. Hand use during task: _____ (uses hand closest to peg only = 0 pt.)
_____ (crosses midline or transfers peg to preferred hand = 1 pt.)

6. CO-CONTRACTION OF NECK:

This test item assesses co-contraction of the neck musculature.

Equipment Needed: One low table and an interesting visual target on the wall.

Procedure:

Position a small mat on top of a low table. Assist the child to lie prone on the table, propping on his elbows with his head extending over the edge. Place a visual target on the wall in front of the child. Interest the child in the target. "SEE THE TOY ON THE WALL? WATCH IT CAREFULLY. I AM GOING TO PUSH YOUR HEAD DOWN BUT DON'T LET ME MOVE YOU. KEEP LOOKING AT THE TOY." Place one hand one the back of the child's head and resist downward into neck flexion. Practice one time, resisting no more than 5 seconds, allowing the child to build up muscle tone. Repeat the instructions if the child does not understand the task. Record the position of the head before applying resistance, then repeat the task, timing the child. The stopwatch should be stopped as soon as the head reaches a position of neutral alignment or slight flexion.

Scoring:

a. Head position during task: _____ (neutral or slight extension = 0 pt.)
_____ (45 to 90° extension = 1 pt.)

b. Amount of resistance applied: _____ (unable to take resistance = 0 pt.)
_____ (slight to maximum = 1 pt.)

c. Number of seconds held: _____ (0 seconds = 0 pt.)
_____ (1 to 5 seconds = 1 pt.)
_____ (6+ seconds = 2 pt.)

7. PRONE, ROLLING PIN TASK:

This test item assesses strength of the trunk extensors, control of bilateral symmetrical movements, and integration of the tonic labyrinthine reflex in prone.

Equipment Needed: One low table, one rolling pin, standard size, and a red yarn ball suspended on a string.

Procedure:

The child remains on the table but is moved forward so that his head and arms extend past the edge. Present a rolling pin for the child to hold. "HOLD THE ROLLING PIN BY EACH HANDLE." Suspend the yarn ball 6" in front of the child at a height slightly above the child's head. Instruct the child, "HIT THE BALL WITH THE ROLLING PIN. SEE HOW MANY TIMES YOU CAN DO IT." Count the number of repetitions that the child lifts the rolling pin up. Note the child's grasp of the handles and position of the head and hips.

Scoring:

a. Maintains grasp on handles: _____ (releases grasp = 0 pt.)
_____ (maintains grasp = 1 pt.)

b. Number of times lifting rolling pin up: _____ (0 times = 0 pt.)
_____ (1 to 5 times = 1 pt.)
_____ (6 to 10 times = 2 pt.)
_____ (11+ times = 3 pt.)

c. Position of hips as child lifts arms: _____ (neutral = 0 pt.)
_____ (extended = 1 pt.)

d. Position of head during task: _____ (neutral or slightly extended = 0 pt.)
_____ (45 to 90° extension = 1 pt.)

8. BELLY-CRAWLING:

This test item assesses stability of the trunk and shoulders while propelling the body forward in alternating movements .

Equipment Needed: One ball, any size.

Procedure:

Instruct the child to lie on his stomach propped on elbows on the mat. Place a ball 6 feet away. Demonstrate belly crawling to the child by propelling forward using only the forearms. "SEE HOW I CRAWL ON MY STOMACH? YOU DO THE SAME THING. SEE IF YOU CAN GET THE BALL." When the child reaches the ball, ask him to push it and crawl forward to that point. It is important that the child does not rest between reaching the ball and pushing it. A large space is necessary so that the child can perform optimally before reaching his fatigue point. Count the number of steps and observe the amount of rotation during belly-crawling.

Scoring:

a. Amount of rotation:
_____ (goes into side-lying as arms step forward = 0 pt.)
_____ (little to no rotation to side = 1 pt.)

b. Number of steps:
_____ (0 steps = 0 pt.)
_____ (1 to 5 steps = 1 pt.)
_____ (6 to 10 steps = 2 pt.)
_____ (11 to 20 steps = 3 pt.)
_____ (21 + steps = 4 pt.)

9. WHEELBARROW WALK:

This test item assesses stability and strength of the trunk, neck, and upper extremity extensors.

Procedure:

Instruct the child to remain on his stomach. "LET'S DO A WHEELBARROW WALK. I WILL PICK UP YOUR FEET AND YOU CAN WALK ON YOUR HANDS. SEE HOW FAR YOU CAN GO." Grasp the child's ankles and hold them up in the air so that the back is slightly arched but not overly extended. Use a large space so that child does not stop to change directions and thereby allowing a rest period. Count the number of steps. Note the child's head and elbow position as well as the amount of extraneous movements of the trunk.

Scoring:

a. Head position during task:	_____	(neutral or slightly extended = 0 pt.)
	_____	(45 to 90° extension = 1 pt.)
b. Elbow position when weight bearing:	_____	(slight to moderate flexion = 0 pt.)
	_____	(full extension = 1 pt.)
c. Amount of extraneous movements:	_____	(many side-to-side movements = 0 pt.)
	_____	(no side-to-side movements = 1 pt.
d. Number of steps:	_____	(0 steps = 0 pt.)
	_____	(1 to 5 steps = 1 pt.)
	_____	(6 to 10 steps = 2 pt.)
	_____	(11 to 20 steps = 3 pt.)
	_____	(21+ steps = 4 pt.)

10. AIRPLANE:

This test item assesses integration of the tonic labyrinthine reflex in prone.

Procedure:

Stand in front of the child. Instruct the child, "WE'RE GOING TO PLAY A GAME CALLED AIRPLANE. SEE HOW I HOLD MY ARMS OUT STRAIGHT FOR WINGS? YOU MAKE WINGS WITH YOU ARMS." Demonstrate holding the arms out at sides (shoulders abducted 90° and elbows fully extended) to make wings. When it is clear that the child understands how to hold his arms, ask the child to assume a hands-and-knees position. Straddle one leg on each side of your body with the child's hips as close to your body as possible. Grasp the child on each side of his thorax so that the trunk is in an arched position. Then stand up while holding the child in the air and adjust the level of support to the shoulders, thorax, waist, or hips, giving the least amount of support necessary for the child to maintain an arched back posture. Then instruct the child, "HOLD YOUR WINGS OUT STRAIGHT. SEE HOW LONG YOU CAN FLY." Begin timing the child with the stopwatch once the level of support has been adjusted. Walk slowly around the room while holding the child. Stop the stopwatch as soon as the child lowers himself below the horizontal position or reaches to hold onto the examiner. Record the placement of support, number of seconds, and symmetry of arms.

Scoring:

a. Placement of support:
_____ (shoulders = 0 pt.)
_____ (mid-chest = 1 pt.)
_____ (waist or hips = 2 pt.)

b. Symmetrical posture of arms:
_____ (arms flexed or asymmetrical = 0 pt.)
_____ (arms abducted at shoulders, elbows extended = 1 pt.)

c. Number of seconds:
_____ (0 seconds = 0 pt.)
_____ (1 to 5 seconds = 1 pt.)
_____ (6+ seconds = 2 pt.)

11. SCOOTER BOARD, BILATERAL SYMMETRICAL MOVEMENTS:

This test item assesses integration of the tonic labyrinthine reflex in prone and bilateral motor coordination.

Equipment Needed: One scooter board.

Procedure:

Place the scooter board on the floor and demonstrate to the child how it moves when pushed gently. "THIS IS MY SCOOTER BOARD. SEE HOW IT MOVES WHEN I PUSH IT? LET'S TAKE A RIDE ON THE SCOOTER BOARD." Position the child prone on the scooter board with support at the chest and hips. Instruct the child, "PUSH WITH BOTH HANDS TOGETHER." Demonstrate the movement of pushing with two hands together. If necessary, pattern the child through the movement. Encourage the child to push until fatigued. Record the child's head, shoulder, and hip position, the number of steps, and amount of extraneous movements during the task.

Scoring:

a. Head position:
_____ (neutral or slightly extended = 0 pt.)
_____ (45 to 90° extension = 1 pt.)

b. Shoulder girdle:
_____ (protracted = 0 pt.)
_____ (retracted = 1 pt.)

c. Hip position:
_____ (neutral or slightly flexed = 0 pt
_____ (extended 10 to 30° = 1 pt.)

d. Amount of extraneous movements:
_____ (side-to-side movements or asymmetry in pushing = 0 pt.)
_____ (no extraneous movements, pushes in a straight line = 1 pt.)

e. Number of steps:
_____ (0 steps = 0 pt.)
_____ (1 to 5 steps = 1 pt.)
_____ (6 to 10 steps = 2 pt.)
_____ (11 + steps = 3 pt.)

12. SCOOTER BOARD, RECIPROCAL ALTERNATING MOVEMENTS:

This test item assesses bilateral motor coordination.

Equipment Needed: One scooter board.

Procedure:

While the child is on the scooter board, instruct him to push with alternating arms by demonstrating the movement. If necessary, move the child through the pattern for a few steps. "THIS TIME YOU ARE GOING TO RIDE WITH YOUR ARMS PUSHING ONE AT A TIME. SEE IF YOU CAN CATCH ME." Encourage the child to push across the room to catch your feet until fatigued. Record the number of steps.

Scoring:

Number of steps:

_____ (0 steps = 0 pt.)
_____ (1 to 5 steps = 1 pt.)
_____ (6 to 10 steps = 2 pt.)
_____ (11+ steps = 3 pt.)

13. **ATNR INTEGRATION:**

This test item assesses integration of the asymmetrical tonic neck reflex in the quadraped position.

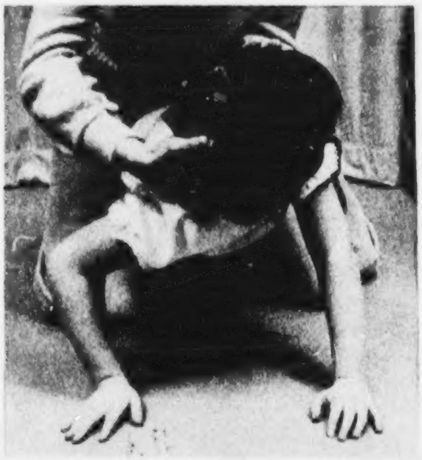
Equipment Needed: Blindfold

Procedure:

Ask the child to assume a hands and knees position. "GET ON YOUR HANDS AND KNEES LIKE A DOG." Assist the child if necessary, taking care that the child does not sit on his heels. Assure that the elbows are not locked in extension by pushing the child back slightly so that the shoulders are not directly over the elbows. Check the elbows for flexibility, positioning them in slight flexion. Place a blindfold over the child's eyes. If the child resists, ask him to close his eyes. Passively turn the child's head to one side. Note the degree of elbow flexion in the skull side arm. Distract the child's attention by talking to him. Turn the child's head to the other side and repeat the same procedure. Note the amount of head resistance when rotated to each side.

Scoring:

a. Degree of resistance of head to right:	_____(moderate to severe = 0 pt.) _____(slight = 1 pt.) _____(none = 2 pt.)
b. Flexion of skull-side arm, head turned to right:	_____(left arm collapses or 90° flexion = 0 pt.) _____(between 10 to 60° flexion = 1 pt.) _____(no flexion = 2 pt.)
c. Degree of resistance of head to left:	_____(moderate to severe = 0 pt.) _____(slight = 1 pt.) _____(none = 2 pt.)
d. Flexion of skull-side arm, head turned to left:	_____(right arm collapses or 90° flexion = 0 pt.) _____(between 10 to 60° flexion = 1 pt.) _____(no flexion = 2 pt.)



14. STNR INTEGRATION:

This test item assesses integration of the symmetrical tonic neck reflex in the quadraped position.

Equipment Needed: Blindfold

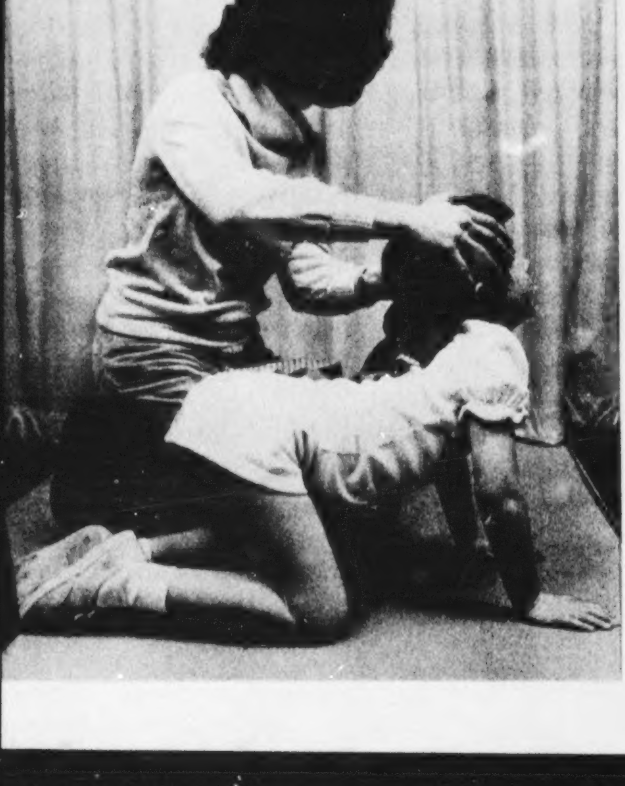
Procedure:

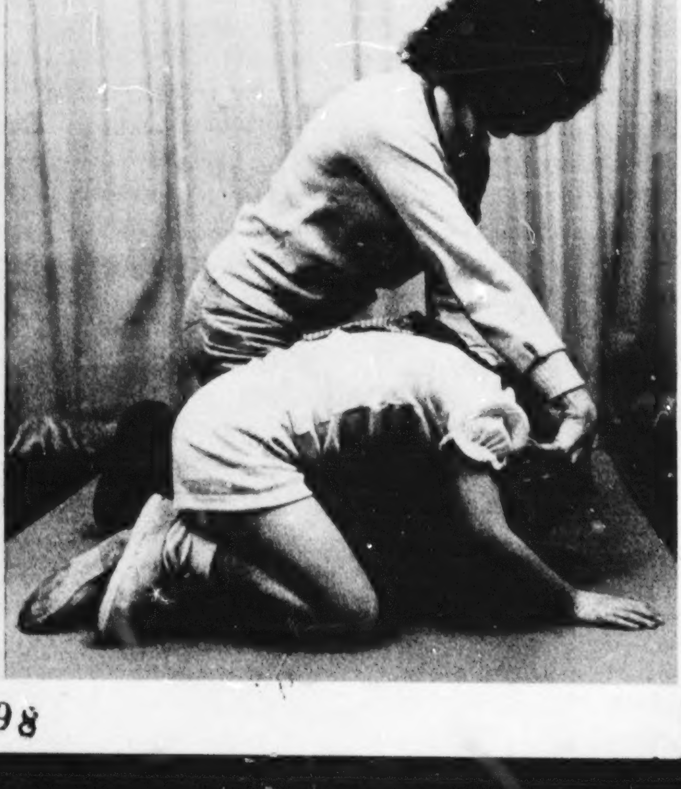
While the child is positioned on his hands and knees and blindfolded, flex the head in the midline by pushing on the back of the head. Distract the child's attention by talking to him as the head is flexed. "NOW LET'S PRETEND THE DOGGIE SNIFFS THE GROUND." Note the position of the arms, hips, and knees. Then extend the head in the midline by lifting the chin. Again, distract the child's attention. "NOW THE DOGGIE LIFTS HIS HEAD IN THE AIR." Note the position of the upper and lower extremities upon neck flexion and extension.

Scoring:

a. Body position upon flexion of the head:
_____ (collapses on elbows or 90° flexion= 0 pt.)
_____ (elbows flex 10 to 60° = 1 pt.)
_____ (no flexion of elbows = 2 pt.)

b. Body position upon extension of the head:
_____ (sits on heels = 0 pt.)
_____ (maintains quadraped position = 1 pt.)





15. QUADRAPED, BAT BALL:

This test item assesses integration of the symmetrical tonic neck reflex.

Equipment Needed: Red yarn ball suspended on a string.

Procedure:

Instruct the child to remain on his hands and knees. (Remove the blindfold.) Suspend a yarn ball on a string, holding it atteye level 8 to 10 inches in front of the child. Begin one foot to the right of midline, steadying the ball. Ask the child to bat the ball. "HIT THE BALL." Then hold it 6 inches to the right of midline, in midline, 6 inches to the left of midline, and one foot to the left of midline. Observe the child's body position.

Scoring:

Maintenance of quadraped position: _____ (sits on heels when lifts arm = 0 pt.)
_____ (maintains position = 1 pt.)

16. TUG OF WAR:

This test item assesses co-contraction of the upper extremities.

Equipment Needed: One six foot length of rope, 1/2 inch diameter

Procedure:

Instruct the child to sit cross-legged on the mat. Sit several feet opposite the child. Give him a six foot length of rope approximately one foot from the end. "HOLD THE ROPE HERE. WE'RE GOING TO PLAY A GAME OF TUG OF WAR." Grasp the other end of the rope and demonstrate pulling one hand over the other. "PULL THE ROPE LIKE THIS. FIRST THIS HAND, THEN THE OTHER. SEE IF YOU CAN WIN." Offer resistance to the child but only enough so that the child can win. Record the amount of resistance applied.

Scoring:

Amount of resistance applied: _____(unable to take resistance = 0 pt.)
_____(slight = 1 pt.)
_____(moderate to maximum = 2 pt.

17. VISUAL TRACKING:

This test item assesses eye movements while tracking in the horizontal and vertical planes.

Equipment Needed: One red yarn ball.

Procedure:

Continue to sit opposite the child. Remove the child's glasses if they are worn. Instruct the child, "KEEP YOUR HEAD VERY STILL WHILE YOU WATCH MY RED SPIDER. WATCH WHERE HE GOES." Move the red yarn ball slowly in a horizontal plane 12 inches in front of the child's eyes. (Do not suspend the ball by the string.) Hold the child under the chin if the head moves. Observe the child's eye movements. Reminders may be given to watch carefully. Then move the yarn ball in a vertical plane similarly.

Scoring:

a. Smoothness of tracking in horizontal plane:
_____ (loses target = 0 pt.)
_____ (midline jump = 1 pt.)
_____ (smooth tracking = 2 pt.)

b. Smoothness of tracking in vertical plane:
_____ (loses target = 0 pt.)
_____ (smooth tracking = 1 pt.)

18. SYMMETRICAL HAND MOVEMENTS:

This test item assesses rhythmic hand movements in a simple symmetrical pattern.

Procedure:

Sit facing the child. Place each hand above each knee in a supinated position. Instruct the child, "WATCH MY HANDS. SEE HOW THEY OPEN AND CLOSE TOGETHER?" Demonstrate opening and closing the hands simultaneously with full finger flexion and extension each time. Move the hands at a rate of one movement per second. Demonstrate three open-close sequences. "NOW YOU DO IT." The child then practices several repetitions. "NOW SEE HOW FAST I MOVE MY HANDS." Repeat demonstration performing one complete open-close sequence every second. "NOW DO YOURS AS FAST AS YOU CAN UNTIL I TELL YOU TO STOP." Start the stopwatch when the child begins and count the number of repetitions up to 10 seconds. If the child moves his hands asymmetrically or without full finger flexion and extension, those repetitions are not counted. Note the symmetry of hand movements.

Scoring:

a. Number of repetitions in 10 seconds:
_____(0 times = 0 pt.)
_____(1 to 5 times = 1 pt.)
_____(6 to 10 times = 2 pt.)
_____(11+ times = 3 pt.)

b. Symmetry of movements:
_____(asymmetrical or uneven rhythm = 0 pt.)
_____(symmetrical movements = 1 pt.)

19. ALTERNATING HAND MOVEMENTS:

This test item assesses rhythmic alternating hand movements in a simple drumming pattern.

Procedure:

Sit facing the child. Rest each hand on each thigh in a pronated position. Instruct the child, "WATCH MY HANDS AGAIN. SEE HOW I MAKE THEM DRUM?" Raise each hand 6 inches off the lap, drumming at a rate of one up-down hand movement per second. Demonstrate 4 drumming movements. "NOW YOU DO IT." After the child has practiced several repetitions and understands the task, demonstrate fast drumming. "SEE HOW FAST I DO MINE NOW." Repeat drumming at a rate of one right-left drumming pair per second. "NOW DO YOU HANDS AS FAST AS YOU CAN UNTIL I TELL YOU TO STOP." Begin timing the child with the stopwatch and count the number of repetitions for 10 seconds. Any drumming pairs completed without alternation are not counted. Note the steadiness of rhythm.

Scoring:

a. Number of drumming pairs in 10 seconds:
_____(0 times= 0 pt.)
_____(1 to 5 times = 1 pt.)
_____(6 to 10 times = 2 pt.)
_____(11+ times = 3 pt.)

b. Steadiness of rhythm:
_____(uneven rhythm = 0 pt.)
_____(steady = 1 pt.)

20. SCHILDER ARM EXTENSION TEST WITH HEAD ROTATION:

This test item assesses the ability to dissociate neck and arm movements with passive head rotation.

Equipment Needed: Blindfold

Procedure:

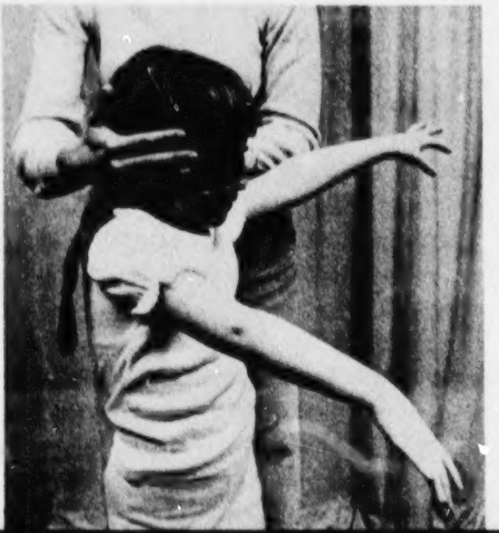
Instruct the child to stand with his feet together, toes even. "STAND HERE WITH YOUR FEET TOGETHER. HOLD YOUR ARMS OUT LIKE THIS WITH YOUR FINGERS WIDE APART." Demonstrate holding the arms in a posture of 90° of shoulder flexion with full elbow extension and abduction of the fingers. Assist the child in assuming the posture and in spreading the fingers. Place them so that the arms are parallel to the floor but not touching. "CLOSE YOUR EYES. I AM GOING TO MOVE YOUR HEAD FROM SIDE TO SIDE." A blindfold may be used if needed. Place one hand on each side of the child's head and turn the head slowly from side to side so that the face looks in each direction. Count slowly to ten seconds to distract the child from the head turning. Note resistance of the head, and position of the trunk and arms during the task.

Scoring:

a. Resistance of head to turning:
_____ (moderate to severe = 0 pt.)
_____ (slight = 1 pt.)
_____ (none = 2 pt.)

b. Steadiness of arms:
_____ (arms lower, diverge or converge below child's waist = 0 pt.)
_____ (arms lower to child's waist level = 1 pt.)
_____ (arms remain steady within 4 to 6" range with minimal convergence or divergence = 2 pt.)

c. Rotation of arms and trunk:
_____ (trunk and arms rotate with head turning = 0 pt.)
_____ (arms and trunk relatively steady = 1 pt.)



21. RESPONSE TO POST-ROTARY VESTIBULAR STIMULATION:

This test item assesses post-rotary nystagmus, balance and head control, and emotional and physiological responses to spinning.

NOTE: Experience in administering this item is necessary in order to reliably measure nystagmus.

Equipment Needed: Post-rotary nystagmus board (Western Psychological Services); one blank wall

Procedure:

Present the child with the nystagmus board. "SEE MY BOARD? LOOK HOW IT SPINS. SIT ON IT HERE WITH YOUR LEGS CROSSED." Assist the child so that he sits centered on the board with legs crossed. "HOLD ONTO THE BOARD HERE." Indicate the center of the side he is facing and help the child to grasp the edge. Using the corner of the room as a vertical reference, tilt the child's head into 30° flexion. Face the child towards a blank wall and kneel on the left side of the child. "I AM GOING TO SPIN YOU AROUND TEN TIMES. WHEN I STOP, YOU LOOK AT THE WALL. DON'T LOOK AT ME. BE SURE TO KEEP YOUR HEAD TITLED LIKE THIS. LOOK DOWN AT YOUR HANDS." Correct the head position if the child moves. Using the child's knee, push to the right ten times at a rate of one revolution every two seconds, keeping up a constant speed of rotation. Avoid touching the child more than is necessary to spin him, holding him only at the knee. After 10 rotations, stop the child suddenly and face him towards the blank wall. Tell the child, "LOOK AT THE WALL, DON'T LOOK AT ME." Start the stopwatch while observing back and forth, horizontal eye movements. If nystagmus stops and changes direction, discontinue timing at the point when it shifts direction. Avoid sitting in the child's visual field. Wait ten seconds and ask the child the following questions: "DID YOU LIKE THE RIDE?"; "IS THE ROOM MOVING?"; "HOW DOES YOUR TUMMY FEEL?"; "DID YOU FEEL LIKE YOU WERE GOING TO FALL?" . Record responses on the scoresheet. If any adverse reactions such as alarm, persistance of balance loss, prolonged dizziness occur, do not continue with the test. Otherwise, repeat the test, spinning the child to the left. "NOW WE'RE GOING THE OTHER DIRECTION. KEEP YOUR HEAD TILTED LIKE THIS. LOOK DOWN AT YOUR HANDS. WHEN WE STOP, LOOK AT THE WALL." Repeat procedures.

Scoring:

a. Number of seconds of nystagmus after spinning to right:
_____(0 seconds = 0 pt.)
_____(1 to 5 seconds = 1 pt.)
_____(6 to 10 seconds = 2 pt.)
_____(11 to 15 seconds = 3 pt.)
_____(16 + seconds = 4 pt.)

b. Amount of excursion after spinning to right:
_____(barely perceptible = 0 pt.)
_____(about one millimeter = 1 pt.)
_____(about 2 or more millimeters = 2 pt.)

Scoring: (Cont'd)

c. Number of seconds of nystagmus after spinning to left:

_____(0 seconds = 0 pt.)
_____(1 to 5 seconds = 1 pt.)
_____(6 to 10 seconds = 2 pt.)
_____(11 to 15 seconds = 3 pt.)
_____(16+ seconds = 4 pt.)

d. Amount of excursion after spinning to left:

_____(barely perceptible = 0 pt.)
_____(about one millimeter = 1 pt.)
_____(about 2 or more millimeters = 2 pt.)

	Right	Left	
e. Balance after spinning:			(loses balance or falls off board = 0 pt.)
			(maintains balance = 1 pt.)
f. Head control during spinning:			(loss of head control = 0 pt.)
			(maintains steady head control = 1 pt.)
g. Enjoyment of activity:			(expresses alarm or fear = 0 pt.)
			(enjoys activity = 1 pt.)
h. Presence of dizziness:			(no signs of dizziness = 0 pt.)
			(expresses signs of dizziness = 1 pt.)
i. Presence of nausea:			(expresses discomfort in stomach = 0 pt.)
			(no signs of nausea = 1 pt.)
j. Sensation of falling:			(no sensation of falling = 0 pt.)
			(expresses feeling of falling = 1 pt.)

APPENDIX D

PROTOCOL SHEET AND SCORE SHEETS

ASSESSMENT OF SENSORI-MOTOR INTEGRATION IN PRE-SCHOOL CHILDREN

By Georgia DeGangi, O.T.R.

Name of Child: ______________________________

Date of Birth: ______________________ Race: ______________

Date of Evaluation: ____________________ Age: ______________

PROTOCOL SHEET

		Postural Control		Reflex Integration	Bilateral Motor Integration
1. Sit-up:		v	/	▨	▨
a. Number of sit-ups:	___ (0=0 pt.) ___ (1-5=1 pt.) ___ (6-10=2 pt.)		▨	▨	▨
b. Hand use during task:	___ Uses hand closest to bean bag only (0 pt.) ___ Crosses midline or transfers bean bag to use preferred hand (1 pt.)	▨	▨	▨	
c. Amount of rotation:	___ (complete or partial=0 pt.) ___ (no rotation= 1 pt.)		▨	▨	▨
2. Muscle Tone:	Left / Right	▨	▨	▨	▨
Moderate to severe hypotonia	___ / ___ (0 pt.)				
Slight hypotonia	___ / ___ (1 pt.)				
Normal tone	___ / ___ (2 pt.)				
Slight hypertonia	___ / ___ (3 pt.)				
Moderate to severe hypertonia	___ / ___ (4 pt.)				
TOTAL SCORE:	___ / ___				
3. Neck Flexion:			▨	▨	▨
Number of repetitions:	___ (0=0 pt.) ___ (1-5=1 pt.) ___ (6-10=2 pt.) ___ (11+=3 pt.)				
		v	/	▨	
	TOTAL:		▨		

		Postural Control		Reflex Integration	Bilateral Motor Integration
		V	V	▨	▨
4. **Monkey:** a. Ability to hold position:	____ (unable=0 pt.) ____ assumes but loses grip when lifted=1 pt. ____ (head lower than 6" below dowel, arms flexed 0 to 45°=2 pt.) ____ (head within 3-6" below dowel, arms flexed greater than 60°=3 pt.)		▨	▨	▨
b. Number of seconds held:	____ (0=0 pt.) ____ (1-5=1 pt.) ____ (6+=2 pt.)		▨	▨	▨
5. **Prone on elbows; pegboard:** a. Body position during task:	____ (rotates to side-lying=0 pt.) ____ (maintains position=1 pt.)	▨			
b. Hand use during task:	____ Uses hand closest to peg only (0 pt.) ____ Crosses midline or transfers peg to use preferred hand (1 pt.)	▨	▨		
6. **Co-contraction of neck:** a. Head position during task:	____ (neutral or slight extension =0 pt.) ____ (45 to 90° extension =1 pt.)			▨	▨
b. Amount of resistance applied:	____ (none=0 pt.) ____ (slight to maximum=1 pt.)			▨	▨
c. Number of seconds held:	____ (0=0 pt.) ____ (1-5=1 pt.) ____ (6+=2 pt.)			▨	▨
7. **Prone, rolling pin task:** a. Maintains grasp on handles:	____ (releases grasp at least once=0 pt.) ____ (maintains grip =1 pt.)	▨		▨	▨
b. Number of times rolling pin lifted up:	____ (0=0 pt.) ____(1-5=1 pt.) ____ (6-10=2 pt.) ____ (11+=3 pt.)	▨		▨	▨
c. Position of hips:	____ (neutral=0 pt.) ____ extend as child lifts arms=1 pt.)	▨		▨	▨
d. Position of head:	____ (neutral or slight extension =0 pt.) ____ (45 to 90° extension =1 pt.)	▨		▨	▨
8. **Belly-crawling:** a. Amount of rotation:	____ (goes into side-lying as steps =0 pt.) ____ (no rotation to side =1 pt.)	▨		▨	▨
b. Number of steps:	____ (0=0 pt.) ____ (1-5=1 pt.) ____ (6-10=2 pt.) ____ (11-20=3 pt.) ____ (21+=4 pt.)	▨		▨	▨
		v	/	▨	
	TOTAL:			▨	
		Co-cont			

		Postural Control		Reflex Integration	Bilateral Motor Integration
		✓	/	▨	▨
9. Wheelbarrow walk: a. Head position during task:	____ (neutral or slight extension =0 pt.) ____ (45 to 90° extension =1 pt.)	▨		▨	▨
b. Elbow position when weight bearing:	____ (slight flexion=0 pt.) ____ (full extension=1 pt.)	▨		▨	▨
c. Amount of extraneous movements:	____ (many side to side movements =0 pt.) ____ (no side to side movements=1 pt.)	▨		▨	▨
d. Number of steps:	____ (0=0 pt.) ____ (1-5=1 pt.) ____ (6-10=2 pt.) ____ (11-20=3 pt.) ____ (21+=4 pt.)	▨		▨	▨
10. Airplane: a. Placement of support:	____ (shoulders=0 pt.) ____ (mid-chest=1 pt.) ____ (waist or hips =2 pt.)	▨		▨	▨
b. Symmetrical posture of arms:	____ (arms flexed or asymmetrical =0 pt.) ____ (arms abducted at shoulders, elbows extended=1 pt.)	▨		▨	▨
c. Number of seconds:	____ (0=0 pt.) ____ (1-5=1 pt.) ____ (6+=2 pt.)	▨		▨	▨
11. Scooter board, bilateral symmetrical movements: a. Head position:	____ (neutral or slightly extended =0 pt.) ____ (45 to 90° extension =1 pt.)	▨		▨	▨
b. Shoulder girdle:	____ (protracted=0 pt.) ____ (retracted=1 pt.)	▨		▨	▨
c. Hip position:	____ (neutral or slightly flexed =0 pt.) ____ (extended 10 to 30° =1 pt.)	▨		▨	▨
d. Amount of extraneous movements:	____ (side to side movements or asymmetry in pushing=0 pt.) ____ (no extraneous movements, pushes in straight line=1 pt.)	▨		▨	▨
e. Number of steps:	____ (0=0 pt.) ____ (1-5=1 pt.) ____ (6-10=2 pt.) ____ (11+=3 pt.)	▨	▨	▨	
12. Scooter board, reciprocal alternating movements: Number of steps:	____ (0=0 pt.) ____ (1-5=1 pt.) ____ (6-10=2 pt.) ____ (11+=3 pt.)	▨	▨	▨	
		✓	/	▨	
		▨		▨	

Item	Scoring	Postural Control	Reflex Integration	Bilateral Motor Integration
13. ATNR Integration: a. Degree of resistance of head to right:	____ (moderate to severe=0 pt.) ____ (slight=1 pt.) ____ (none=2 pt.)	▨		▨
b. Flexion of skull-side arm, head turned to right:	____ (left arm collapses or 90° flexion=0 pt.) ____ (between 10 to 60° flexion=1 pt.) ____ (no flexion =2 pt.)	▨		▨
c. Degree of resistance of head to left:	____ (moderate to severe=0 pt.) ____ (slight=1 pt.) ____ (none=2 pt.)	▨		▨
d. Flexion of skull-side arm, head turned to left:	____ (right arm collapses or 90° flexion=0 pt.) ____ (between 10 to 60° flexion=1 pt.) ____ (no flexion =2 pt.)	▨		▨
14. STNR Integration: a. Body position upon head flexion:	____ (collapses on elbows or 90° flexion=0 pt.) ____ (elbows flex 10 to 60°=1 pt.) ____ (no flexion of elbows=2 pt.)	▨		▨
b. Body position upon head extension:	____ (sits on heels=0 pt.) ____ (maintains quadruped position =1 pt.)	▨		▨
15. Quadruped, bat ball: Maintenance of quadruped position:	____ (sits on heels when lifts arm =0 pt.) ____ (maintains position =1 pt.)	▨		▨
16. Tug of war: Amount of resistance applied:	____ (unable to take=0 pt.) ____ (slight=1 pt.) ____ moderate to maximum=2 pt.)		▨	▨
17. Visual tracking: a. Smoothness of tracking in horizontal plane:	____ (loses target=0 pt.) ____ (midline jump=1 pt.)____ (smooth tracking=2 pt.)	▨	▨	▨
b. Smoothness of tracking in vertical plane:	____ (loses target=0 pt.) ____ (smooth tracking=1 pt.)	▨	▨	▨
TOTAL:	____________ Ocular-Motor Score	▨	▨	▨
				▨

		Bilateral Motor Integration	Reflex Integration	Vestibular Function	
18. Symmetrical hand movements: a. Repetitions in 10 seconds:	____ (0=0 pt.) ____ (1-5=1 pt.) ____ (6-10=2 pt.) ____ (11+=3 pt.)		▨	▨	
b. Symmetry of movements:	____ (asymmetrical or uneven=0 pt.) ____ (symmetrical=1 pt.)		▨	▨	
19. Alternating hand movements: a. Drumming pairs in 10 seconds:	____ (0=0 pt.) ____ (1-5=1 pt.) ____ (6-10=2 pt.) ____ (11+=3 pt.)		▨	▨	
b. Steadiness of rhythm:	____ (uneven=0 pt.) ____ (steady=1 pt.)		▨	▨	
20. Schilder Arm Extension Test with head rotation: a. Resistance of head to turning:	____ (moderate to severe=0 pt.) ____ (slight=1 pt.) ____ (none=2 pt.)	▨		▨	
b. Steadiness of arms:	____ (arms lower, diverge or converge below child's waist=0 pt.) ____ (arms lower to child's waist level=1 pt.) ____ (arms remain steady within 4 to 6" range with minimal convergence or divergence=2 pt.)	▨		▨	
c. Rotation of arms and trunk:	____ (much rotation=0 pt.) ____ (relatively steady=1 pt.)	▨		▨	
21. Response to Post-rotary Vestibular Stimulation:		▨	▨	L	R
a. Number of seconds of nystagmus after spinning to right:	____ (0=0 pt.) ____ (1-5=1 pt.) ____ (6-10=2 pt.) ____ (11+=3 pt.)	▨	▨		
b. Amount of excursion after spinning to right:	____ (barely perceptible=0 pt.) ____ (about 1 millimeter=1 pt.) ____ (about 2 or more millimeters =2 pt.)	▨	▨		
c. Number of seconds of nystagmus after spinning to left:	____ (0=0 pt.) ____ (1-5=1 pt.) ____ (6-10=2 pt.) ____ (11+=3 pt.)	▨	▨		
d. Amount of excursion after spinning to left:	____ (barely perceptible=0 pt.) ____ (about 1 millimeter=1 pt.) ____ (about 2 or more millimeters = 2 pt.)	▨	▨		
				L	R

		Postural Control	Reflex Integration	Vestibular Function	
		▨	▨	L	R
21. e. Balance after spinning in each direction:	____ (loses balance or falls off board=0 pt.) ____ (maintain ____ (maintains balance=1 pt.)	▨	▨		
f. Head control during spinning:	____ (loss of head control=0 pt.) ____ (maintains steady head control=1 pt.)	▨	▨		
g. Enjoyment of activity:	____ (expresses alarm or fear=0 pt.) ____ (enjoys activity=1 pt.)	▨	▨		
h. Presence of dizziness:	____ (no signs of dizziness=0 pt.) ____ (expresses signs of dizziness =1 pt.)	▨	▨		
i. Presence of nausea:	____ (no signs of nausea=0 pt.) ____ (expresses discomfort in stomach=1 pt.)	▨	▨		
j. Sensation of falling:	____ (no sensation=0 pt.) ____ (expresses feeling of falling =1 pt.)	▨	▨		
		▨	▨	L	R
		▨	▨		

SCORE SHEET I

For use with those children who complete the entire test.

Compilation of Scores

To compute the indices in each category, add the total from the protocol sheet and record, then refer to the table "INDEX ANALYSIS" for areas I through III below. Use the table "INDIVIDUAL ITEM ANALYSIS" for areas IV and V below. Check the box which applies for each.

		Score Interpretation		
	Upper range of normal	Low range of normal	Slight to significant delay	Severely delayed
I. POSTURAL CONTROL: A. Flexion Index:				
B. Extension Index:				
C. TLR Index: (Total of flexion and extension indices)				
D. Co-contraction Index:				
II. REFLEX INTEGRATION:				
III. BILATERAL MOTOR INTEGRATION:				
IV. OCULAR-MOTOR CONTROL: (refer to items 17a and 17b)				
V. MUSCLE TONE: (refer to item 2)				

SCORE SHEET II

For those children who could only complete part of the test.

Compilation of Scores

To determine the child's function in each area, record the individual score for those test items completed on the protocol sheet, then refer to the table "INDIVIDUAL ITEM ANALYSIS" for interpretation of the scores. Check the box and/or boxes which apply, then compute the overall level of function for each area if possible.

	Score Interpretation			
I. POSTURAL CONTROL:	Upper range of normal	Low range of normal	Slight to significant delay	Severely delayed
A. Stability in flexion: 1a. #sit-ups				
1c. Rotation				
3. Neck flexion				
4a. Monkey pos.				
4b. Monkey; # sec.				
OVERALL LEVEL:				
B. Stability in extension: 5a. Prone on elbows				
7b. Rolling pin; # lifts				
7c. Hip position				
7d. Head pos.				
8a. Belly crawl, rot.				
8b. # steps				
9a. Wheelbarrow, head pos.				
9b. Elbow pos.				
9c. Extraneous movements				
9d. # steps				
10a. Airplane, support				
10c. # seconds				
11a. Scooter, head pos.				

	Score Interpretation			
	Upper range of normal	Low range of normal	Slight to significant delay	Severely delayed
11b. Scooter, shoulders				
11c. Hip position				
11d. Extraneous movements				
OVERALL LEVEL:				
C. TLR Integration: Total flexion and extension categories : OVERALL LEVEL				
D. Co-contraction:				
6a. Head pos.				
6b. Resistance				
6c. # seconds				
16. Tug of war				
OVERALL LEVEL:				
II. REFLEX INTEGRATION: 13a. ATNR-right; head resist				
13b. ATNR-right; elbow pos.				
13c. ATNR-left; head resist				
13d. ATNR-left; elbow pos.				
14a. STNR: head flexion				
14b. STNR: head extension				
15. Quad., bat ball				
20a. Schilder, head resist				
20b. Steady arms				
20c. Trunk rotation				
OVERALL LEVEL:				
III. BILATERAL MOTOR INTEGRATION: 1b. Sit-up, hand use				
5b. Prone on elbows, hand use				

	Score Interpretation			
	Upper range of normal	Low range of normal	Slight to significant delay	Severely delayed
7a. Rolling pin; grasp				
10b. Airplane; symmetry-arms				
11e. Scooter board; bilateral step				
12. Scooter; alternate steps				
18a. Open-close: repetitions				
18b. Open-close: symmetry				
19a. Drumming; repetitions				
19b. Drumming; symmetry				
OVERALL LEVEL:				
IV. OCULAR-MOTOR CONTROL:				
17a. Visual track; horizontal				
17b. Visual track; vertical				
OVERALL LEVEL:				
V. MUSCLE TONE:				
2. Left:				
Right:				

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Appendix B

Project Approval by the Johns Hopkins University Review Board on the Use of Human Subjects

THE JOHNS HOPKINS UNIVERSITY • BALTIMORE, MARYLAND 21218

DEPARTMENT OF PSYCHOLOGY

July 13, 1978

Dr. Max Mueller
Bureau of Education for the Handicapped
Research Division, Donohoe Building
400 6th Street, Southwest
Washington, D.C. 20202

Re: "The Assessment of Postural Control, Reflex Integration, and
Bilateral Motor Coordination of Young Handicapped Children,"
by Lawrence A. Larsen

Dear Dr. Mueller:

The Department of Health, Education, and Welfare has approved a general institutional assurance (Number G0352) dated September 19, 1975, submitted by the Faculty and Administration, Faculty of Arts and Sciences, The Johns Hopkins University, in compliance with the requirements for the protection of human subjects prescribed in Part 46 of Title 45 of the Code of Federal Regulations (45 CFR 46).

In accordance with the provisions of that general assurance I certify that a statement of assurance submitted by Lawrence A. Larsen, Principal Investigator, in connection with a grant identified as "The Assessment of Postural Control, Reflex Integration, and Bilateral Motor Coordination of Young Handicapped Children," was reviewed and accepted by the Review Board on the Use of Human Subjects at its regularly scheduled meeting held on 11 July 1978. A copy of the duly-signed and approved statement of assurance is on file in the Board's office and in the Office of Sponsored Projects.

Sincerely,

Alphonse Chapanis

Alphonse Chapanis
Professor
Chairman, Review Board on
the Use of Human Subjects

AC:jn
cc: Dr. Lawrence A. Larsen ✓
Mr. H. R. Proctor
Information copy

ASSURANCE IN CONNECTION WITH A SINGLE PROJEC INVOLVING HUMAN SUBJECTS

Evening College and Summer Session
The Johns Hopkins University

This statement has been prepared on behalf of Lawrence A. Larsen, Assistant Professor in the Division of Education, who will serve as Project Director, and Georgia DeGangi, a master of science student in the Division of Education, in connection with an application for a grant titled "The Assessment of Postural Control, Reflex Integration, and Bilateral Motor Coordination of Young Handicapped Children" (Identifying #443-AH80102), submitted by the Evening College and Summer Session of Johns Hopkins University to the Bureau of Education for the Handicapped of the Department of Health, Education, and Welfare. Telephone communication has been received stating that this proposal has been funded under CFDA 13.443 Student Research for the period July 1, 1978 through June 31, 1979. A formal notification of grant award is expected on or around July 1, 1978.

The Board confirms that Dr. Larsen and Ms. DeGangi have read and agree to comply with the provisions of a general institutional assurance (Number G0352), dated September 19, 1975, submitted by the Faculty and Administration, Faculty of Arts and Sciences, The Johns Hopkins University, in compliance with the requirements for the protection of human subjects prescribed in Part 46 of Title 45 of the Code of Federal Regulations (45 CFR 46), as most recently amended on 11 January 1978, said assurance having been approved and accepted by the Department of Health, Education, and Welfare on October 22, 1975.

In an initial review of the above-referenced research proposal, information supplied to the Board by the Project Director reveals that the following procedures are to be used in this project: The primary purpose of this project is the development of a measurement device, specific assessment procedures, and norms based on normal development for the early identification of delays and deficits in the postural control, reflex integration, and bilateral motor coordination of young handicapped children. Test norms will be developed using a sample of 120 children including 40 three year olds, 40 four year olds, and 40 five year olds. The test will include approximately twenty-five items that will take about one-half hour to administer to an individual child. The test items will be sequenced according to difficulty with the least stressful items at the end of the test to minimize efforts of fatigue. Test items will involve the use of various toys and equipment such as pegboards, scooter boards, and bean bags. The test activities involve no inconvenience or discomfort to the child. The only activity that is potentially aversive involves spinning the child on a vestibular board while in a sitting position. Some children experience dizziness following this task for a brief duration. As the test will be administered on an individual basis, it can be terminated should the child respond with fear to any test items. The test items are designed to be enjoyable games for the child, and such a response is therefore unlikely.

The test results for individual children will be kept strictly confidential and no child will be identified by name in the research. Only group trends will be used to establish test norms and developmental sequences. Individual test results will be available only to the child's parents.

Based on a review of the procedures described briefly above, the risks to the rights and welfare of the subjects in this project or activity are likely to be no greater than would be experienced in ordinary, everyday living.

The Board states that, in its opinion, adequate safeguards against these risks have been provided and that any probable risks are outweighed by the sum of the benefits of this activity to the subjects and the importance of the knowledge to be gained. This opinion is justified by the following reasons:

1. Children in four day care nurseries will be screened in bilateral motor coordination, postural control, and reflex integration.
2. Children identified as having possible developmental deficits or delays in any of these areas will be referred to diagnostic clinics or other facilities for additional evaluation and for therapeutic treatment as necessary.
3. The children participating in the study will receive individual attention while tested in enjoyable motor activities, providing an overall positive experience for each child.

In the opinion of the Board the informed consent procedures to be used by the Project Director will be adequate and appropriate. As evidenced by the documentation attached to this statement, these procedures are presented to each parent in the form of a letter describing the procedures, the rights of the parent, and confidentiality in the presentation of research findings. A signed informed consent form will be obtained for each child.

The Board agrees to arrange for a continuing exchange of information and advice between itself and the Project Director particularly to deal with proposed changes in project or activity design, or with emergent problems which may alter the investigational situation with regard to the criteria cited above. This exchange will be implemented through the use of letters to the chairman of the board when such changes or problems occur.

This institution will provide whatever professional attention or facilities are required to safeguard the rights and welfare of human subjects.

The signatures, names and occupations or titles of the members of the Board are listed below.

"The Assessment of Postural Control, Reflex Integration,
and Bilateral Motor Coordination of Young Handicapped
Children," by Lawrence A. Larsen

Robert A. Gordon

Robert A. Gordon, Associate Professor
Department of Social Relations
The Johns Hopkins University

Judith A. Hall, Assistant Professor
Department of Psychology
The Johns Hopkins University

Robert T. Hogan, Professor
Department of Psychology
The Johns Hopkins University

Ru Chih C Huang

Ru Chih C. Huang, Professor
Department of Biology
The Johns Hopkins University

John A Mote

John A. Mote, Clergyman
Wilson Memorial United Methodist Church

Michael G. Ventura, Staff Attorney
The Johns Hopkins Hospital

Ernst O. von Schwerdtner

Ernst O. von Schwerdtner, Professor
(Retired) Towson State University

Alphonse Chapanis

Alphonse Chapanis, Professor
Department of Psychology
Chairman, Review Board on the Use of
Human Subjects
The Johns Hopkins University

Emily M. Ahern, Professor
Department of Anthropology
The Johns Hopkins University

July 11, 1978

Date of Board Approval

Official signing for Institution H R Proctor

H. R. Proctor
Office of Sponsored Projects
The Johns Hopkins University
Garland Hall
Baltimore, Maryland 21218
(301) 338-8138

Appendix C

Parent's Checklist

Dear Parent:

I would appreciate if you could fill out the following information for me. It will be used to determine if you have any concerns in your child's motor development and to get a general idea about the level your child is functioning at in motor skills. Please add any other comments you may have.

Name of Child:______________________________

Date of Birth:__________________________

1. Are you concerned about your child's gross and fine motor skills? If so, what are your concerns? Yes____ No____

2. Is your child clumsy, awkward, or uncoordinated when performing various tasks? Yes____ No____

3. Have you ever consulted a pediatrician or a motor specialist (such as a physical therapist) about any motor problems your child might have? Yes___ No____ Does Not Apply____

4. Please check off which skills your child is able to do. The skills given below range from three years through six years of age. If you do not know if your child is able to do the task, please mark it with a question mark.
   ______ Pedals a tricycle
   ______ Jumps with both feet together
   ______ Strings large beads
   ______ Holds a pencil in a mature, adult manner
   ______ Cuts with scissors on a line
   ______ Hops on one foot
   ______ Walks up and downstairs alternating feet without holding on to the rail
   ______ Buttons small buttons
   ______ Laces shoes
   ______ Screws a jar lid on
   ______ Skips alternating feet
   ______ Shows a definite hand preference
   ______ Dresses himself independently

Thank you very much for your cooperation in this study.

Georgia DeGangi

Georgia DeGangi, O.T.R.

Appendix D

Informed Consent Form

D-2

THE JOHNS HOPKINS UNIVERSITY • BALTIMORE, MARYLAND 21218

EVENING COLLEGE AND SUMMER SESSION

We would like to invite you and your child to participate in a study being conducted by the Johns Hopkins University that investigates the motor development of preschool children. As children develop, they learn how to use their hands and bodies in a variety of coordinated activities. At present, there are few developmental tests that measure how each child uses his hands together; how he develops hand dominance; how he positions his head, trunk, and arms during activities; and how his reflexes have developed and become integrated. Very little is known about the developmental progression of these skills and, for this reason, we hope to develop an instrument that can be used to test children to identify, at an early age, developmental delays and mild physical handicaps. We would like your child to participate in the project so that we can establish developmental norms for this purpose.

The test that we are developing involves the use of various toys and equipment items such as scooter boards. The test activities involve no discomfort or inconvenience to the child. Nothing is attached to the child, and the equipment and techniques involve no apparent risk the child's welfare. On the contrary, most children find the test items and process to be a very enjoyable experience.

As is standard policy, the test results for individual children will be kept confidential and no child will be identified by name in the research. Since we are interested in group results rather than individual performance, only group trends will appear in any published reports. You are, of course, entitled to know your own child's results if you desire.

Some of the children will be selected to be tested a second time to see if the testing procedures produce consistent results. This is important to establish the reliability of the test. Thus, if you give your permission for your child to participate, it may be possible that he or she will be tested on two separate occasions.

A questionnaire is enclosed with this letter that lists several developmental milestones that are achieved by children at different ages. We would appreciate it if you would complete the questionnaire and return it with a signed copy of this consent form. The information on the questionnaire will be used to determine if any children in the group have any motor coordination problems that are already known by the parents.

If you are willing to have your child participate in this project, please sign the statement of consent below and return this letter and the completed questionnaire in the enclosed envelop. You may keep the second copy of this letter for your own records. If you would rather not have your child participate, we will certainly understand and support your decision. If you have any questions about the project now or in the future, you can contact either Dr. Larsen at 301-338-8273 or Ms. DeGangi at 202-625-7675.

Sincerely yours,

Lawrence A Larsen
Lawrence A. Larsen, Ph.D.
Assistant Professor of Education
Georgia DeGangi
Georgia DeGangi, O.T.R.
Graduate Student in Education

STATEMENT OF CONSENT

We, the parents of ____________________, hereby consent to have our child participate in the motor development testing program described above in this letter. We understand that all data collected will be maintained in confidence with the exception that we will have access to the test scores of our own child. We further understand that we may withdraw this consent at any time.

______________________________ ______________________________
Signature of Mother Signature of Father

__________________ __________________
Date Date

Appendix E

Letter to Parents

GEORGETOWN UNIVERSITY HOSPITAL
3800 RESERVOIR ROAD, N.W.
WASHINGTON, D.C. 20007

UNIVERSITY AFFILIATED PROGRAM
FOR CHILD DEVELOPMENT

625-7676

Name of Child: ______________________________

Age: ______________________

School: ____________________________________

Dear Parent:

Your child was tested by an occupational therapist at school and was found to be normal in his/her motor skills. The test included muscle tone, strength and stability of the trunk and arm muscles, coordination of the two hands, and development of a specialized hand. These skills are necessary for refinements in fine and gross motor abilities as well as perceptual skills.

I greatly appreciate your participation in this project. Your child's test scores will be compiled with those of other children to arrive at norms for use in testing handicapped children.

Sincerely,

Georgia DeGangi, OTR

Georgia DeGangi, O.T.R.
Occupational Therapist

DIVISION OF GEORGETOWN UNIVERSITY MEDICAL CENTER

Appendix F

Sample Activities for Parents

GEORGETOWN UNIVERSITY HOSPITAL
3800 RESERVOIR ROAD, N.W.
WASHINGTON, D.C. 20007

UNIVERSITY AFFILIATED PROGRAM
FOR CHILD DEVELOPMENT

625-7676

TRUNK CONTROL

The first gross motor skills to develop are those involving the head and trunk. The neck and trunk muscles give the child stability as he moves. If these muscles are not well developed, the child will have difficulty controlling the fine movements of his hands and may have difficulty aiming, reaching, or grasping a toy accurately.

Trunk control first develops in the flexors of the body. These are the muscles that help the child to sit up from lying on his back. Trunk control further develops in the extensors of the neck and trunk. This extension is necessary for your child to become stable in holding different body postures.

Activities for Trunk Flexion:

___ 1) Play a game of "rowing a boat." Sit facing your child and hold hands. Bend his knees. As one sits up, the other will lay down in a rowing motion. You can also hold an elastic rope instead of each other's hands.

___ 2) Seat your child in a chair with his back against the wall. Roll a ball to him for him to kick with both feet. Be sure that the chair is just high enough so that his feet are slightly off the floor.

___ 3) Hold a suspended yarn ball a few inches above your child's head. See how many times he can hit the ball with his head.

___ 4) Pop-it beads, a pop gun, accordian, or balloon blower are all good toys.

___ 5) Jumping is an excellent way to encourage flexion in the trunk. Give your child a piece of foam or a pillow to use. You may have to help your child bend at the knees and jump up to get the sensation of this skill. When he can do it alone, hold a pole for him to touch or ask him to jump over bean bags on the floor.

___ 6) "Hippity Hop" is a ball marketed that is designed for the child to sit on it while he bounces around the room.

___ 7) Climbing activities can be done on a jungle gym at the playground or with a trapeze or chin-up bar placed in a doorway. Think of lots of different tricks like hanging from his feet, or swinging.

___ 8) Have your child sit on a scooter board. Give him a hoop to hold while you hold onto the other end. Then have him push with his feet across the room.

DIVISION OF GEORGETOWN UNIVERSITY MEDICAL CENTER

____ 9) Crab walk.

____10) Tug of war game while your child kneels. Be sure that he alternates his hands as he pulls.

____11) A suspended inner tube provides many good activities. Your child can swing in it while sitting or he can grab hold of the tire, curling his arms and legs around the inside, chin touching the tire. You can place a piece of foam underneath and have him fall as part of the game.

____12) Ask your child to lie on his back. Hold a long dowel lengthwise for your child to cross his arms and legs over. Lift the dowel in the air as your child holds on tight, forehead touching the dowel. See if he can do it for 20 seconds.

Activities for Trunk Extension:

___ 1) Wheelbarrow walking: hold your child's legs at the knees or ankles and ask him to walk on his hands. Make it a game by having him walk to a ball and then push it along.

___ 2) Ask your child to lie on the bed with his head, arms, and shoulders extending past the edge. Place different objects on the floor or on a low stool if your child has difficulties reaching. Hold a coffee can in the air and have your child pick up the toy (clothespins, puzzle pieces, etc.) and drop it in the can. Hold the can in different positions to make it more difficult for him.

___ 3) Place your child on his hands and knees or if he is unable to do this, lie him on his stomach. Get behind him and straddle each of his legs on each side of your hips. If your child is small, put one leg on each side of one of your knees. Hold your child at the mid-chest level and lift him up so that he has to arch his back. As your child becomes stronger, lower your hands to hold him nearer the hips. Gently bounce your child in this position except if he is spastic to help him hold himself up. While in this position you can tilt your child forward to the ground to pick up a toy. This position is very tiring so limit your game to only 5 minutes.

___ 4) Lie your child on his stomach on a scooter board. Encourage him to push with his hands across the room. Try having him ride down an incline outdoors. Accelerating down the ramp will help your child to lift his head. Try other games like having your child push himself into a tower of cardboard boxes.

___ 5) Suspend an inner tube outdoors so that your child can ride inside while on his stomach. The swinging motion will help your child to lift his head up.

Other Toys for Trunk Extension:

Position your child as is described earlier while using one of the activities described below. Toys that are good use two hands together in a symmetrical or alternating movements. This helps to develop the neck and back extensors equally on both sides of the body. They also require the arms to extend during part of the movement.

___ 1) Rolling pin activities: flatten dough; roll your child a ball and have him hit it back with the rolling pin; hold a suspended ball and ask your child to hit it with the rolling pin. To make the game more difficult, mark the rolling pin with three color strips so that you can ask your child to hit the ball with the "red."

___ 2) Plastic accordian toy.

___ 3) Build with large blocks into a high tower. Hand the blocks to your child on either side of him so that he has to turn his body to grasp them with 2 hands.

___ 4) A spinner toy that operates by pulling the handles in and out after initially winding the string.

___ 5) Ask your child to hold a long dowel behind his neck without touching his neck. See how long he can hold it.

___ 6) Large balls can be used for throwing into a box, knocking over bowling pins or milk cartons, etc.

___ 7) Pull apart toys such as pop-it beads.

___ 8) Toys with a pull string such as talking toys.

___ 9) Lift a blanket overhead with your child by holding the edges of the blanket. Make big waves by moving it up and down. You can put a ball on the blanket and see if you can hold it up without the ball falling off.

___10) Give your child an "airplane" ride by positioning your child as in #2. He can hold his arms out straight like in wings or he can hold a hoop to steer as he flies.

___11) Punch a sand bag or a suspended pillow.

Georgia DeGangi

Georgia De Gangi, O.T.R.
Occupational Therapy

F-5

GEORGETOWN UNIVERSITY HOSPITAL
3800 RESERVOIR ROAD, N.W.
WASHINGTON, D.C. 20007

UNIVERSITY AFFILIATED PROGRAM
FOR CHILD DEVELOPMENT

625-7676

ACTIVITIES TO DEVELOP BILATERAL MOTOR INTEGRATION

Bilateral Symmetrical Activities:

___1) Pull apart and put together pop beads.

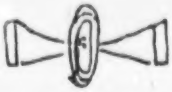
___2) Use finger paints to make large circular movements with the hands. Make symmetrical movements.

___3) Clapping cymbols, rhythm sticks, shaking wrist bells or shakers simultaneously with each hand, playing an accordian, and clapping to music are all excellent activities.

___4) Throw and catch a large ball using two hands. A large ball will force your child to use two hands.

___5) Build with large boxes or large blocks that require two hands to hold them.

___6) A spinner toy requires a pulling motion with two hands to operate it.



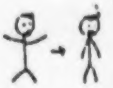
___7) Rolling pin activities offer much variety. Hold a suspended ball and ask your child to hit it with the rolling pin with two hands. Roll the pin over dough or clay.

___8) Kneading dough for bread.

___9) Jumping activities are very good. Position low obstacles for your child to jump over such as blocks, hoops, etc. Encourage him to land on two feet together.

___10) Put a ping pong ball in a gelatin mold tin and ask your child to tilt the tin so that the ball rolls inside, then reverse direction.

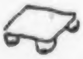
___11) Jumping Jacks, or angels in the snow are patterns requiring symmetrical movements.



___12) Have your child hold a hoop with two hands while pushing a ball across the room with the hoop.

___13) Give your child streamers or a dowel with ribbons attached to the end for each hand to hold. Have him imitate waving them overhead, to the side, and in different patterns.

___14) Have your child lie on his stomach on a scooter board and push with two hands together.



DIVISION OF GEORGETOWN UNIVERSITY MEDICAL CENTER

Activities contrasting the two body sides: 3 years and up

___1) Beat various rhythms on a drum by alternating hands. Have your child beat out names of people or words.

___2) Crawling through obstacle courses.

___3) Crawl with one leg on each side of a long bamboo pole.

___4) Hold a cut-out Clorox bottle in each hand. Ask your child to catch bean bags with them. Then ask him to transfer a ball from one bottle to the next and back again.

___5) Roll a tire on either side of the body using alternating hands.

___6) Have your child lie on a scooter board on his stomach and push with alternating hands as if "swimming".

___7) Finger games such as "einsy-weinsy spider" and "ten little Indians".

___8) String large beads or spools.

___9) Tug of war, stressing hand over hand approach.

___10) Alternate hands up and down a broomstick.

___11) Alternate hopping.

___12) Hold a paddle in each hand. Roll a ball from one hand to the next by paddling.

___13) Wheelbarrow walk.

___14) Riding a tricycle.

___15) Have your child sit on a scooter board. Give him a bathroom plunger to propel himself in a rowing motion, first on one side, then the other.

Georgia DeGangi, OTR
Georgia DeGangi, O.T.R.
Occupational Therapy

FINE MOTOR/PERCEPTUAL ACTIVITIES

Compiled by Dolly Arroyo, O.T.

Level 1:

1. Let the child hold a cup or a bowl steady and show him how to stir with a spoon.
2. Demonstrate folding a piece of paper in half. Encourage the child to imitate motions of folding and creasing.
3. Demonstrate pasting activities. Encourage the child to hold the paper steady in one hand while pasting with the other. Help him make a collage with brightly colored bits of paper.
4. Demonstrate rubbing with a flat side of a crayon. Let the child experiment making rubbings over various surfaces (table top, sidewalk, wood, floor, metal grates). Child must hold paper steady in order to rub.
5. Tape paper to two corrugated cardboard pieces, one with ribs running horizontally (-) and the other with ribs vertically (1). Start the child drawing on a groove. Decrease assistance as he gains skill.

Level 2:

1. Draw a circle on the floor and have the child walk around it.
2. Draw a circle on a piece of paper with a thick crayon. Encourage the child to trace over it with his finger and then with a crayon.
3. Present the child with a picture of a circle and encourage him to copy it. Reward the child by making a face out of his circle.
4. Provide the child with rice, beans, cornmeal and show him how to pour them from one container to the next. Don't expect him to do so accurately at first.
5. Using a small pitcher or tea pot, help the child to pour his own juice or milk into his cup. Gradually decrease your assistance as he gains skill.
6. Thread a plastic yarn needle with string. Let the child use this to make a necklace by stringing macaroni or beads together.
7. Help the child lace his shoes by pushing the lace through and pulling it out. Hold the shoe steady for him and position the eyelet so that he can see it.
8. Show the child how to unbuckle an adult's leather belt. Allow him to practice with the belt.
9. Demonstrate spreading butter, jelly or peanut butter on crackers or toast. Let him try it. Use soft bread and rolls as he gains skill.

10. Cut a piece of paper into four squares and repeat the above activity.

11. Cut a piece of colored paper in half. Show the child how the two halves make a whole when put back together. Encourage him to put them back together.

12. Glue a large, simple magazine picture on a piece of cardboard. Cut into a four-piece puzzle and show the child how the pieces fit together. Have him try it, helping him when necessary.

13. Show the child several simple objects and tell the child their names. Put the objects into a paper bag or into a box with a hole cut out. Encourage the child to reach in and to tell you what objects he feels, i.e., cotton ball, block, pencil, spoon, toy car, large wooden bead, small cup. Have him pull the items out to check his selection. Encourage him to correct himself. (You may want to have a matching set of items so the child can point to the item he is feeling if he is unable to name it.)

Level 3:

1. Large piece puzzles.

2. Shape lotto.

3. String hollow macaroni.

4. Finger play songs, i.e. "Where's Thumb-Kin?".

5. Tinkertoys.

6. Building block designs.

7. Dial telephone numbers.

8. Make piggybank out of small milk cartons; make slit in top large enough to slip coins through.

9. Draw large circle or circular shape with a thick crayon around a picture chosen by your child. Let child cut out the picture using the thick line as a guide. (It's possible for the child to make a book of special pictures.)

10. Punch holes around a cardboard backed picture. Have your child lace around the picture.

11. String different sized beads.

12. Have the child turn the pages of a storybook while being read to.

13. Have your child open doors by turning handles.

Appendix G

Validity Questionnaire

G-2

GEORGETOWN UNIVERSITY HOSPITAL
3800 RESERVOIR ROAD, N.W.
WASHINGTON, D.C. 20007

UNIVERSITY AFFILIATED PROGRAM
FOR CHILD DEVELOPMENT

625-7676

QUESTIONNAIRE

After you have had the opportunity to use the assessment on several children, please fill out this questionnaire and return it to me by May 30th. Thank you!

Name of Therapist: ______________________ Center: ________________

1. How many children did you administer the test to? ________

2. Please check the ages of those children tested and mark a "+" if the test was useful or a "0" if it was not for that age.

   3 years _____ 4 years ______ 5 years _____ 6 years ______
   7 years _____ 8+ years _____

3. If you tested any children older than 5 years of age, please state any problems you may have encountered in administering the test items.

4. In order to determine the usefulness of this test with a variety of disabilities, please check off those categories that the children you tested were in. (In some cases more than one may apply.) Mark one of the following depending on the usefulness of the test: Useful "+", not useful "0", only part of the test useful "P".

   General fine motor delay ______
   General gross motor delay ______
   Overall developmental delay ______
   Learning disabled ______
   Cerebral Palsy:
   ______ hypotonic
   ______ spastic
   ______ athetoid

   Mental retardation:
   ______ Mild
   ______ Moderate
   ______ Severe
   Seizure disorder ______
   Autistic or autistic-like ______
   Other ______________________
   ____

5. Did you feel that the test accurately assessed:

   a. postural control? Yes ____ No ____
   b. bilateral motor integration? Yes ____ No ____
   c. reflex integration? Yes ____ No ____
   d. vestibular-based functions? Yes ____ No ____

   If not, please elaborate.

6. Was it difficult for you to find the equipment to administer the test? Yes _____ No _____. If so, what pieces of equipment were difficult to find?

7. Was the rationale for development of this test clearly presented in the introduction and review of the literature? Yes ____ No ____ Did Not Read ____

8. Were the test procedures understandable? Yes ____ No ____. If not, please list items by number which were not clear and what type of correction should be made.

9. Was the scoring criteria clear and understandable? Yes ____ No ____. If there was any doubt about how to score a particular item, please list the item(s) by number and state what needs further clarification.

10. Was it difficult to interpret the scores using the tables? Yes ____ No ____. If so, what problems did you encounter?

11. Was it helpful to have the reliability tables and explanation grouped with the test description? Yes ____ No ____. Would it have been placed better as an appendix? Yes ____ No ____

12. Was it difficult to understand the statistical analysis done on the test? Yes ____ No ____

13. Was it easy to relate the test findings to treatment goals and activities? Yes ____ No ____

14. What things did you like about the test? (If not covered above.)

15. What didn't you like about the test? (If not covered above.)

16. What changes should be made in the test?

17. Would you recommend this test for use by other O.T.s? Yes ____ No ____
    By other P.T.s? Yes ____ No ____

I would appreciate any other comments you might have.

Mail to: Georgia DeGangi, O.T.R.
Georgetown University Child Development Center
3800 Reservoir Road, N.W.
Washington, D.C. 20007